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THE TWENTY-SEVENTH

ANNUAL REPORT

OF THE

MARYLAND AGRICULTURAL EXPERIMENT STATION

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COLLEGE PARK,

PRINCE GEORGE COUNTY, MARYLAND

1913-1914.

The Maryland Agricultural Experiment Station

CORPORATION.

The Board of Trustees of the Maryland Agricultural College.

Agricultural (Station) Committee of the Board of Trustees:

GOVERNOR P. L. GOLDSBOROUGH, (Ex-Officio)	Annapolis.
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J. HAROLD WALSH	Upper Falls.
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STATION OFFICERS AND STAFF.

HARRY J. PATTERSON	*Director and Chemistry.*
SAMUEL S. BUCKLEY	*Animal Pathology.*
J. B. S. NORTON	*Botany and Plant Pathology.*
THOS. B. SYMONS	*Director of Extension Work.*
N. SCHMITZ	*Agronomy.*
E. H. BRINKLEY	*Farm Superintendent.*
THOS. H. WHITE	*Vegetable and Floriculture.*
CHAS. O. APPLEMAN	*Plant Physiology.*
*A. B. GAHAN	*Entomology.*
ROY H. WAITE	*Poultry.*
F. S. HOLMES	*Stone Fruits.*
C. P. SMITH	*Seed Inspector.*
*G. E. WOLCOTT	*Dairy Extension.*
W. R. BALLARD	*Pomology and Small Fruits.*
C. L. OPPERMAN	*Supt. Ridgely Farm.*
R. BRIGHAM	*Sheep Husbandry.*
E. N. CORY	*Entomologist.*
R. C. ROSE	*Associate Botanist.*
L. B. BROUGHTON	*Assistant Chemist.*
W. M. HILLEGEIST	*Secretary.*
R. S. ALLEN	*Assistant Animal Husbandry*
MISS L. E. CONNER	*Librarian.*
H. FORD	*Treasurer.*

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*In cooperation with the U. S. Department of Agriculture.

The Station is located on the B. & O. R. R. and City and Suburban Electric Car Line, eight miles north of Washington, D. C.
Bell Telephone—Berwyn Exchange.

Visitors will be welcomed at all times, and will be given every opportunity to inspect the work of the Station in all its departments.

The Bulletins and Reports of the Station will be mailed regularly, free of charge to all residents of the State who request it.

ADDRESS:
AGRICULTURAL EXPERIMENT STATION.
College Park, Md.

LETTER OF TRANSMITTAL.

To His Excellency, P. L. Goldsborough,

Governor, and President of the Board of Trustees,

Annapolis, Maryland.

SIR:—In accordance with the provisions of Section No. 3 of the Act of Congress, approved March 2, 1887, "To Establish Agricultural Experiment Stations," etc., I have the honor to transmit the Twenty-seventh Annual Report of the Maryland Experiment Station for the fiscal year ending June 30, 1914.

Very respectfully yours,

H. J. PATTERSON,

Director of the Experiment Station.

July, 1914.

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THE MARYLAND AGRICULTURAL EXPERIMENT STATION

Vol. 27. 1913-191 .

TWENTY-SEVENTH ANNUAL REPORT OF THE MARYLAND AGRICULTURAL EXPERIMENT STATION.

For the Year Ending June 30, 1914.

By H. J. Patterson, Director.

To the Board of Trustees.

Gentlemen:—I have the honor to submit the following report as to the work of this Institution for the past fiscal year, together with recommendations for the coming year.

General Statement.

In the main the investigations pursued during the year were outlined in the report of one year ago. The general plant and equipment have been improved, and all is in a fairly satisfactory shape. The investigations have been pursued with energy and enthusiasm, and most of the results obtained have been well received by both the farmer and the scientist.

Financial Condition.

The demands upon the Station increase much faster than the income, but most interests have been served within the present resources.

The appropriation made by the last Legislature for soil fertility investigations will become available next October. This will allow the Station to greatly extend this phase of its work.

The appropriation for extension and demonstration work made by United States Congress will relieve the Station of some of the expense it has incurred for this class of work. I would recommend that the special State appropriation for demonstration work which has been used by the Experiment Station be assigned to the Extension Service.

The statements on the following pages give the details as to the expenditures made during the past year:

MARYLAND AGRICULTURAL EXPERIMENT STATION.

Receipts, 1913-14.

	Adams Fund.	*Hatch Fund.*
Appropriations—United States	$15,000.00	$15,000.00

Disbursements, 1913-14.

Salaries	9,804.96	14,785.10
Labor	553.17	214.90
Postage and Stationery	127.75	
Freight and Express	6.40	
Heat, Light, Water and Power	654.74	
Chemicals and Laboratory Supplies	114.94	
Seeds, Plants and Sundry Supplies	264.40	
Fertilizers	84.50	
Feeding Stuffs	1,029.19	
Library	379.26	
Tools, Machinery and Appliances	93.61	
Furniture and Fixtures	54.00	
Scientific Apparatus and Specimens	1,228.91	
Traveling Expenses	55.11	
Buildings and Land	549.06	
	$15,000.00	$15,000.00

The above is a true copy from the books of this office.

HERSCHEL FORD, *Treasurer.*

MARYLAND AGRICULTURAL EXPERIMENT STATION.

STATION FARM.

Receipts, 1913-14.

Balance July 1st, 1913	$ 78.14
Sundry Receipts from Sale of Produce and Labor	9,037.21
	$9,115.35

Disbursements, 1913-14.

Labor	$ 7,853.34
Postage and Stationery	100.53
Freight and Express	314.63
Heat, Light, Water and Power	9.70
Seeds, Plants and Sundry Supplies	184.79
Fertilizers	31.25
Feeding Stuffs	49.00
Tools, Machinery and Appliances	141.75
Live Stock	8.53
Traveling Expenses	210.29
Buildings and Land	53.25
Balance June 30th, 1914	158.29
	$9,115.35

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HERSCHEL FORD, *Treasurer.*

MARYLAND AGRICULTURAL EXPERIMENT STATION.

STATE ACCOUNT.

Receipts, 1913-14.

Balance July 1st, 1913	$ 2,219.28
State Appropriation	10,000.00
Interest on Deposits	73.51
	$12,292.79
Overdraft	76.86
	$12,369.65

Disbursements, 1913-14.

Salaries	$ 1,169.99
Labor	2,721.70
Traveling	734.92
Drainage and Irrigation	85.65
Fertilizers	111.50
Chemical Supplies	23.31
Freight and Express	258.22
Live Stock	258.52
Feed Stuffs	621.06
Publications	631.73
Building and Repairs	867.13
Heat, Light and Water	158.22
Seeds, Plants and Sundry Supplies	789.71
Library	72.84
Furniture and Fixtures	518.54
Tools, Implements and Machinery	536.55
Postage and Stationery	161.26
Scientific Apparatus	536.58
Insurance	1,982.32
Exhibits	109.90
Contingent Expenses	20.00
	$12,369.65

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HERSCHEL FORD, *Treasurer.*

MARYLAND AGRICULTURAL EXPERIMENT STATION.

HORTICULTURAL ACCOUNT.

Receipts, 1913-14.

Balance July 1st, 1913	$ 377.81
State Appropriation	5,000.00
Interest on Deposits	5.97
	$5,383.78

Disbursements, 1913-14.

Salaries	$ 670.33
Tools, Implements and Machinery	204.30
Postage and Stationery	48.11
Seeds, Plants and Sundry Supplies	587.48
Fertilizers	517.86
Traveling Expenses	56.72
Library	44.16
Labor	721.09
Building and Repairs	48.26
Publications	704.46
Heat, Light and Water	103.54
Freight and Express	292.08
Furniture and Fixtures	166.90
Balance June 30th, 1914	1,218.49
	$5,383.78

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HERSCHEL FORD, *Treasurer.*

MARYLAND AGRICULTURAL EXPERIMENT STATION.

DEMONSTRATION FUND.

Receipts, 1913-14.

Balance July 1st, 1913	$ 735.02
State Appropriation	3,000.00
	$3,735.02

Disbursements, 1913-14.

Salaries	$ 614.23
Exhibits—Horticultural	87.76
Postage and Stationery	81.72
Traveling Expenses	950.19
Labor	426.76
Tools, Implements and Machinery	56.88
Seeds, Plants and Sundry Supplies	132.74
Fertilizers	144.11
Balance June 30th, 1914	1,240.63
	$3,735.02

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HERSCHEL FORD, *Treasurer.*

MARYLAND STATE BOARD OF AGRICULTURE.

Biological Laboratory.

Receipts, 1913-14.

Balance July 1st, 1913	$ 862.48
State Appropriation	6,250.00
Sundry Receipts	2,092.00
	$9,204.48

Disbursements, 1913-14.

Salaries	$4,488.36
Traveling Expenses	152.89
Hog Cholera Serum	603.50
Building and Repairs	204.87
Sundry Supplies	298.38
Furniture and Fixtures	83.20
Scientific Apparatus	544.49
Labor	234.69
Library	2.00
Tools, Implements and Machinery	216.91
Heat, Light and Water	5.95
Chemical Supplies	61.60
Live Stock	1,838.60
Telephone and Telegraph	13.37
Feed Stuffs	248.78
Freight and Express	20.72
Balance June 30th, 1914	186.17
	$9,204.48

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Herschel Ford, *Treasurer.*

MARYLAND STATE BOARD OF AGRICULTURE.

SEED INSPECTOR.

Receipts, 1913-14.

Balance July 1st, 1913	$ 945.51
State Appropriation	2,000.00
	$2,945.51

Disbursements, 1913-14.

Salaries	$ 1,045.18
Labor	232.50
Scientific Apparatus	65.60
Seeds, Plants and Sundry Supplies	107.44
Chemical Supplies	2.33
Traveling Expenses	195.11
Furniture	94.87
Tools, Implements and Machinery	4.13
Publications	322.09
Balance	876.26
	$2,945.51

The above is a true copy from the books of this office.

HERSCHEL FORD, *Treasurer.*

PUBLICATIONS.

The following list shows the subjects, authors and number of pages of each bulletin issued during the past year. These publications give more or less of a history of the Station's activities and the main results which have been obtained during each fiscal year.

Date	No.	Subject.	Author.	No. Pages.
July....1913.		26th Annual Report.	H. J. Patterson.	
Oct.....1913.	178	Apple Orchard Experiments.	W. R. Ballard	1-58
Feb.....1914.	179	Clover and Vetch Seed Sold in Maryland.	C. P. Smith.	59-88
Mar.....1914.	180	Tomatoes: — Varieties, Diseases, Culture.	Thos. H. White. J. B. S. Norton. J. F. Monroe.	89-134
Mar.....1914.	181	Inexpensive Aids in Producing Sanitary Milk.	R. W. Lamson.	135-155
Apr.....1914.	182	Small Fruits.	W. R. Ballard.	155-180
May.....1914.	183	Chemical and Physiological Studies of the Ripening of Potatoes.	C. O. Appleman.	181-226
June....1914.	184	Curd as an Index of the Food Value of Milk.	S. S. Buckley.	227-242

BUILDINGS AND REPAIRS.

Buildings have all been repaired from time to time as they seemed to require it. The poultry building, which was destroyed by fire last year, has been replaced by a brick building. This is more substantial and better suited to the work than the old building.

SYNOPSIS OF INVESTIGATIONS IN PROGRESS.

The investigations in progress are mostly a continuation of those noted in previous reports. Only changes will be noted here, and for further details see printed list in the twenty-sixth annual report.

AGRONOMY.

The investigations in this, as well as in many other fields, develop new problems as they advance.

In addition to the work at the Station, we have had cooperative tests with farmers as follows:

On Wheat, with	250 farms.
On Winter Oats, with..................	40 farms.
On Soja Beans, with...................	18 farms.
On Alfalfa, with	60 farms.
On Corn, with	15 farms.
On Sweet Corn, with...................	2 farms.
On Sudan Grass, with..................	10 farms.
On Phosphoric Acid and Lime..........	20 farms.
Total	415 farms.

A new series of green manuring tests was begun this season with the object of determining—

(A) Under what degree of fertility will a legume add the most nitrogen.

(B) What legume is best to use as a soil improver.

(C) Under what conditions and at what stage of growth will legumes give best results for soil improvement.

There will be 85 1/10 acre plots used in these investigations.

BOTANY AND PLANT PATHOLOGY.

The most of the investigations in this department are being pursued under the provisions of the Adams Fund.

Project D—Conditions affecting Tomato Blight.

Project E—Affect of Sulphur and Sulphur Compounds on Cell Structure.

Project F—Life History of the Tomato Blight Fungus.

Project G—Life History of Fruit Potting Sclerotinias.

Project H—Corelations of Disease Resistance.

PLANT PHYSIOLOGY.

Investigations now in progress in the Laboratory of Plant Physiology—

1. Changes in Irish Potatoes During Storage. First report in Bulletion No. 167.
2. A Biochemical Study of After-ripening in the Potato Tuber. First report now ready for publication.
3. A Physiology Study of the Rest Period in Potato Tubers. First report now ready for publication.
4. Metabolic Changes in Tubers During Sprouting.
5. Factors Influencing Bud Corelation in Potato Tubers.
6. Relation of Oxidases to Respiration in Potato Tubers.
7. A Chemical and Physiological Study of the "Little Sprout" Disease of the Potato Tuber.

DAIRY INVESTIGATIONS.

The new work along dairy lines consisted of—

(1) A Study of Some Economical Aids in Improving the Quality of milk. The results of these tests are given in Bulletin No. 181.

(2) A Study of the Effect of Mixing Feed on Digestibility.

(3) A Study of the Composition and Digestibility of Sudan Grass.

(4) Cow-Judging Demonstrations at Fairs.

(5) Feed and Milk Records of Cows at Fairs.

(6) Demonstrations of Concrete Silo Construction.

SHEEP AND SWINE HUSBANDRY.

The work with these two branches of animal husbandry consisted in making surveys so as to determine the extent and condition of these industries in Maryland. The results of the surveys will be used as a basis for future investigations.

HORTICULTURAL INVESTIGATIONS.

(Vegetable and Floriculture.)

(1) Tests of Systems of handling Crimson Clover as a Green Manure for Tomatoes.
(2) Factors which Influence the Climbing Habits of Lima Beans.
(3) A Study of Disease Resistance in Cabbage.
(4) A Study of Methods of Raising Cabbage Seed.
(5) Seed Selection of Potatoes.
(6) Comparison of Foreign and American Varieties of Rhubarb.
(7) Tests of Ornamental Plants for Use on Farm Home Grounds.
(8) Greenhouse work with Roses, Carnations Chrysanthemums, Snap Dragons, Mignonette, Sweet Peas, Ferns, Lettuce and Tomatoes.

(Pomology and Small Fruits.)

(1) Breeding and Selection of Bush Fruits for Eastern Maryland.
(2) Testing and Breeding of Spring and Fall Types of Strawberries.
(3) Training Systems with Grapes.
(4) Grape Breeding.
(5) Testing of New Apple Seedings from New York Experiment Station.

(Stone Fruits.)

(1) Study of Factors Influencing Hardness of the Peach.
(2) Orchard Heating for the Prevention of Frosts.
(3) Observations on Nut Trees.

POULTRY INVESTIGATIONS.

The new building constructed to take the place of the one destroyed by fire has been completed.

It is built of white brick face both sides. The building has four rooms on the first floor and five rooms in the basement. There has been installed in this building a 3,000-egg Hall incubator. This machine has given good satisfaction.

Much work has been done by this department in making exhibits at fairs, etc., judging poultry, lecturing at farmers' meetings and preparing articles for the press. Several circular letters have been prepared to facilitate answering correspondence.

PUBLICITY WORK.

More has been done the past year than ever before in getting the results of the Experiment Station and College work before the public through short popular articles in the daily and county press.

For several months we have had a page each Sunday in the Baltimore Sun. For the past four months we have had one column each week in 92 of the county papers. This matter is prepared and sent to the papers in plate form.

It is our expectation to review all our Station publications with timely articles of this kind.

RIDGELY FARM.

The last Legislature passed a bill for the purchase of a farm at Ridgely, Maryland, to be used as a sub-station by the Experiment

Station. The farm contains 50 acres and is suitable to the general farming and small fruits grown in that section. The State appropriated $1,500 a year for two years for maintaining the farm. This money will be available after October 1st. This amount is too small to carry on many investigations, and will probably need to be supplemented from other sources in order to put the farm on a basis expected by the people of that county.

I recommend that the Director be allowed to arrange for the organization of the force and work for that farm, subject to the approval of the Agricultural Committee.

Demonstration Work.

I would recommend that the demonstration work which the Station has been doing be transferred to the Extension Service and combined with the work to be done under the provisions of the Smith-Lever Bill.

Biological Laboratory.

The failure of the State to make any provisions for the support of the biological laboratory for the manufacture of hog cholera serum will necessitate the curtailment of some phases of that work, but I think we can continue to manufacture serum, and have a supply available for the farmers that can be procured at fairly economical rates. I recommend that the work be continued on a commercial basis, and within the provisions of the law establishing the laboratory.

I recommend that Dr. S. S. Buckley be placed in charge of this laboratory.

Hog Cholera Serum Report for May, 1914.

Amount of Serum sold from May 1, 1913, to May 1, 1914	125,000 c. c.
Amount of Serum on hand May 1, 1914	171,215 c. c.
Amount of Serum produced during May, 1914	29,330 c. c.
Total	200,545 c. c.
Amount of Serum distributed during May, 1914	10,285 c. c.
Balance, June 1, 1914	190,260 c. c.

Seed Inspection.

The law providing for seed inspection was amended and made more stringent. The appropriation for this work was increased to $3,000. The increase in the amount of work necessitated will require the entire time of one man. I, therefore, recommend that Prof. C. P. Smith be relieved of his College duties and assigned entirely to the seed inspection work.

Farmers' Day.

The second annual farmers' day was held in conjunction with the dedication of "Calvert Hall" on May 30th. The work of the Station was inspected by nearly 600 people. The plan of having a farmers' day seems to be appreciated, and I would recommend that the holding of such days be continued.

THE MARYLAND AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 178 OCTOBER 1913.

APPLE ORCHARD EXPERIMENTS.

By W. R. Ballard.

Introduction.

The Station orchard which was planted in the spring of 1889 was planned partly with the idea of testing varieties and partly to test northern grown trees in comparison with those produced in Maryland nurseries. The soil upon which the trees were planted, was a clay loam with the exception of the southeastern corner of the plot where a few round gravel stones appeared. The plot was about four acres in extent and located on the rather low, level land, east of the Experiment Station buildings. Apple trees were set 36 feet apart each way with peaches and pears as fillers. Owing to the location, the peaches seldom bore a crop because of late spring frosts. They were removed in the spring of 1900.

The pear trees of all varieties grew well and produced several good crops but blight finally attacked them, killing some varieties outright and severely injuring others. The variety "Blightproof" was the only one remaining in 1913. Owing to the number of missing trees this orchard was no longer useful for experimental purposes and it was removed in the spring of 1913.

The orchard was kept carefully cultivated with the disc harrow from early spring until about the last of July when a cover crop of crimson clover was sown. This was disced or plowed under in the spring. In 1900 one application of fertilizer was applied with the cover crop. This consisted of a mixture of 1800 pounds of dissolved phosphate rock and 200 pounds of muriate of potash, 300 pounds of this mixture being applied per acre, and in 1903, 20 bushels of lime were applied to the acre.

NORTHERN VS. SOUTHERN GROWN TREES.

In the test of northern and southern grown trees the following varieties were used, Red June, Early Harvest, Red Astrachan, Sweet Bough, Maiden Blush, Fall Pippin and Gravenstein. Five trees of each of the above varieties were secured from Ellwanger & Berry, Rochester, New York, and a like number from Franklin Davis Nursery Co., Baltimore, Maryland. Trees of each variety from the two sources were planted side by side.

On account of depredations it was practically impossible to get any accurate data as to yields of fruit although all varieties bore well. However, as far as general observation could determine, no striking variation could be noted in the productiveness or quality of fruit on trees from different sources.

Measurement of growth revealed no superiority of one over the other. At the time of removal 22 out of the original number of northern grown trees were standing, while 25 of the southern grown were left. Root rot and trunk canker seemed to attack the trees without any relation to their source and individual variation of trees were sufficiently marked to effectively obscure any advantage which might have been due to the region in which the nursery trees were grown. While no apparent results of value have developed from this test, it still may serve to emphasize more clearly the need of special care in the planning of experiments of this character. The great variation known to exist in the mixed lot of seeding stocks which nurserymen use in propagation is enough, in itself, to cause a disturbing element. It is, of course, true that nurserymen attempt to correct this difficulty by working strong growing varieties on weak growing stock and vice versa, yet this would not correct any inherent susceptibility to the root rots and other troubles to which the stock is subject. The origination of a vigorous stock which could be readily propagated from cuttings would be a very desirable acquisition for experimental work of this nature.

COVER CROP TESTS.

In the spring of 1901 plots were laid off across all varieties including those used in the above test and various cover crops were sown to test their effect on the growth of the trees. One row was used for each plot.

No. 1 was seeded to white clover.

No. 2 was seeded to alsike clover, to be mowed and left on the land.

No. 3 was plowed in the spring and given clean culture until the last of July when crimson clover was sown.

No. 4 was plowed in the spring and sowed to cowpeas early in June, and left to fall on the land and the residue plowed under in the spring.

No. 5 was the same as No. 4 except that the cowpeas were plowed down in September and rye was sown to be plowed down in the spring.

No. 6 was the same as No. 3.

No. 7 and 8 were given clean culture until September when rye was sown as a winter cover.

This plan was rigidly followed until the removal of the trees. The trees were carefully and regularly pruned and sprayed.

After the second year the clovers on plots 1 and 2 gradually disappeared, blue grass, orchard grass and other grasses taking their places.

The effect of these treatments on the trees was not marked except that the foliage on the sod plots turned light green earlier in the fall. There was little difference in the quality of the fruit, the sod plot being fully equal to the other plots. However, the soil was of such a nature as not to be easily affected in dry seasons. The use of the cover crops undoubtedly made some difference in the soil as is indicated by tests of soil from the different plots made in the greenhouse and reported upon in bulletin No. 127. While data is not yet available from the truck crops now growing on these plots general observation indicates more or less marked differences.

The following table gives the number of trees standing and the average spread of limbs on plots 2, 3, 4, and 5 in July, 1912. These represent the plots upon which the northern and southern trees were grown. After the first year or so plots 1 and 2 were treated the same, so that only No. 2 is included.

Plots	2	3	4	5
Number of trees standing	10	11	9	7
Average spread of limbs in feet	26.4	24.5	25.7	26.8

Observations on Varieties.

The following notes on varieties are appended to indicate their behavior in this particular section. The relative high humidity together with the long, warm seasons in this locality afford a very favorable condition for the development of fungous troubles. In the more important apple sections of the State such diseases are less prevalent and more easily controlled. These varieties were given two or three summer sprayings and since this was sufficient to give a very good grade of fruit on many varieties, the development of fungous troubles on others may give some indication of their greater susceptibility under the conditions as noted above. While the notes on cedar rust represent only two seasons' observations, yet this includes one season in which the disease was unusually prevalent. Other troubles have been observed for a longer period.

American Summer—Probably the healthiest variety in the orchard, fruit resembles Summer Pearmain but is milder in flavor. Season is the same.

Bailey Sweet—Subject to bitter rot, and two thirds of the trees succumbed to root rot.

Baltzley—A yellow sweet apple, of little value.

Benoni (one tree)—Attacked by root rot, productive but fruit is small.

Bentley Sweet—So susceptible to bitter rot that the trees had to be taken out in order to remove a very active source of infection for other varieties.

Bonum—Quite healthy, being noticeably free from codling moth and fungous diseases. Trees productive and fruit attractive and of good color.

Buckingham—Somewhat subject to blight and root rot.

Chenango—Fruit considerably subject to rot and blight. Two out of three trees died from root rot.

Domine—Quite susceptible to blight, a vigorous grower.

Early Harvest—Free from blight, subject to root rot. Tree only moderately vigorous, fruit small on old trees.

Early Ripe—Trees vigorous and productive, some indication of root troubles.

Fall Pippin—Very vigorous, badly injured by blight and subject to scab.

Gravenstein—Six out of ten trees died from root troubles. A vigorous grower.

Grimes—Trees succumbed to the collar blight while in prime bearing condition, subject to twig blight.

Jefferis—Somewhat subject to blight, and rot.

Jonathan Buler—Tree moderately vigorous, fruit subject to rot.

Kinnaird—Tree moderately vigorous, somewhat subject to scab.

Lankford—Trees made poor growth, not productive.

Lawver—Vigorous and fairly healthy, some scab.

Maiden Blush—Vigorous trees, some root rot and cedar rust and considerable twig blight.

Mother—Trees subject to root rot, not productive, some scab and blight.

Nero—Subject to cedar rust.

Rambo—Trees vigorous, subject to cedar rust and blight, fruit rots badly some seasons.

Red Astrachan—Trees very vigorous, productive, fruit subject to rot, some scab.

Red June—Considerable root rot, some blight, considerable scab. Fruit small on old trees.

Shockley—Subject to cedar rust, productive.

Smokehouse—Trees vigorous, a little blight.

Stark—Trees vigorous, subject to cedar rust, some blight, fruit attacked by black rot.

Summer Rambo—Trees very vigorous, subject to cedar rust, only moderately productive.

Sweet Bough—First to be attacked by root rot, moderately vigorous. Considerable blight.

Yellow Transparent—Trees moderately vigorous, somewhat subject to twig blight, productive.

THE BLOOMING PERIOD.

The period during which any particular variety is in bloom bears quite an important relation to its liability to injury from late spring frosts. Many of the early blooming sorts often fail entirely or at least the crop is seriously curtailed from this cause, while a few of those which bloom late are seldom damaged. In recent years plant breeders have turned their attention to this subject and some definite work is being done toward getting varieties which remain dormant late in the spring. Information as to the blooming habit is of value from this standpoint as well as serving to guide planters in regions subject to late spring frosts. Reliable data is often difficult to obtain from the fruit growers themselves and records obtained in the Station orchards may be supposed to apply only to this particular region. The number of years that observations have been made on the different varieties is given in the accompanying table. The periods indicated in the chart represent the average for the years noted, based upon the date of first bloom and the date at which the petals began to fall. While scarcity of bloom on some varieties and other abnormal conditions may seem to throw some varieties out of their proper position, the chart on the whole may be taken as a fair indication of the blooming habit of these varieties in this section. Varieties are arranged in the order of their first bloom.

BLOOMING RECORDS.

VARIETIES	No. of Years	APRIL	MAY
Yellow Siberian	4	12—20	
Bledsoe	3	12—22	
Grant	4	12—23	
Colton	4	13—23	
Molasses	5	14—23	
Duchess	4	14—24	
Transcendent	4	15—25	
Ben Davis	4	15—26	
Montreal	3	16—23	
Martha	5	16—25	
Gano	4	16—26	
Arkansas	4	16—27	
Early Harvest	6	16—27	
Bismarck	5	16—29	
Black Ben	4	17—26	
Whitney	5	17—26	
Domine	6	17—27	
Early Ripe	7	17—28	
Major	7	18—24	
Shannon	3	18—26	
Wealthy	7	18—27	
Smith (Cider)	6	18—27	
Paragon	6	18—27	
York	7	18—27	
Gravenstein	7	18—27	
Mills	5	18—28	
Pine Stump	4	19—25	
Fallawater	7	19—26	
Alaska	5	19—27	
Mann	7	19—27	
Laura	4	19—28	
Stayman	7	19—28	
Smokehouse	7	19—28	
American Summer	7	19—29	
Benoni	5	19—29	
Shockley	7	19—30	
Baltzley	7	19———	1
Stark	7	19———	1
Nero	7	19———	1
Maiden Blush	7	19———	4
Yellow Transparent	5	19———	4
Givens	3	20—23	
Nickajack	2	20—25	
Delicious	4	20—26	
Heiges	5	20—27	
Bramley	4	20—27	
Henrick	5	20—28	
Red Astrachan	6	20—29	
Kerr	4	20—29	
Jefferis	7	20—30	
Gilbert	5	20—30	
Summer Rambo	6	20———	1
Lankford	4	20———	1
Jonathan Buler	7	20———	1
Grimes	7	20———	2
Bloomfield	7	21—26	

VARIETIES	No. of Years	APRIL	MAI
Williams	3	21—27	
Warner	4	21—27	
Porter	5	21 - 28	
Ivanhoe	3	21—28	
Akin	3	21—28	
Wolf River	5	21—28	
Stella	5	21—28	
Oliver	5	21—29	
Ponyik	4	21—29	
Shackelford	4	21—29	
Collins	5	21—29	
Summer Pearmain	5	21—29	
Arkansas Black	7	21—29	
Bonum	7	21—30	
Rambo	6	21——	1
Chenango	6	21——	1
Sweet Bough	6	21——	2
Fall Pippin	7	21——	2
Lawver	7	21——	2
Berkley	4	22—27	
Ben Adams	4	22—28	
Winesap	5	22—29	
Buckingham	6	22——	1
Beach	5	22——	1
Pewaukee	4	23—30	
Marengo	5	23——	2
Bailey Sweet	6	23——	3
Mother	6	23——	3
Kinnaird	6	23——	3
Gillespie	3	24—27	
Dickinson	3	24—27	
Red June	6	24—29	
Chicago	3	24—29	
July	3	24—30	
Quarter	3	24—30	
Rome	4	24——	3
Ingram	3	27——	6

* APPLE CULTURE.

The Apple Industry in the East.

There is a rapidly growing interest in apple culture over nearly all sections of the United States where apples can be grown, but in no section is there a healthier interest than is springing up in Maryland. Not only are our own citizens waking up to the fact that apple growing is one of the most satisfactory and profitable of out-door employments, but people from many other states are realizing the same thing and are writing for information on climate, soil, and best location in Maryland for apple culture. While this industry will not jump into existence over large areas almost instantly like it does in the Far West, it will take on a permanent and improved form together with a rapid growth and development. The insect and disease situation is well enough understood now so that there is no cause for the repetition of the terrible alarm which followed the spread of the San Jose scale a few years ago.

The man who intends to raise apples must understand at the outset that he has a continual fight on his hands and must get down to good, hard, honest and intelligent work to make a real success of the venture. This statement, however, need not frighten the man with pluck, but should prevent the overcautious and timid one from embarking into something which would probably not be carried to a successful completion.

Although none of the startling records of enormous profits have been made in the East as in the West, yet the writer firmly believes that with the same money investment, the same intelligence, the same work, the same modern methods of growing, packing and selling, and the same hustle and organization used in the West, Maryland can equal in profits any section in the Great West in producing and marketing apples. The western apples do take on a higher finish, but it is only skin deep, and beneath the skin where flavor and quality are stored, the Maryland apples excel their western rivals.

Natural Conditions.

The natural conditions of Maryland for apple production could hardly be improved. On the Eastern Shore the climate is tempered by the adjacent large bodies of water, and the summer varieties ripen in June and early in July while prices are high. The many streams afford shipping outlets by water, and the soil is especially adapted to apple culture, particularly the sandy loams. The same is true of Southern Maryland. The northern portions of the State have rather heavier soils rolling in contour in the north and mountainous in the west, but nearly all well adapted to varieties of all seasons, and particularly to

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*The following pages have been taken largely from Bulletin No. 144, Apple Culture, by Prof. C. P. Close. The subject matter has been somewhat revised and some new material added to bring it up to date.

the fall and winter sorts because the summer kinds ripen too late to bring the highest prices.

SOILS.

The writer prefers above all others a rich, sandy loam with clay subsoil for this makes a most favorable home for the tree roots and can be worked early in spring and soon after a heavy rain without fear of puddling and baking. It also responds readily to the use of fertilizers and cover crops and produces fruit of highest color and early in ripening. The gravel soils are excellent also.

The clay loams and even heavy clay will produce fine apples if properly handled and thoroughly drained. To loosen up the heavy soils, plenty of manure and cover crops must be used, and they must not be worked when too wet or they will puddle, nor on the other hand be plowed when too dry or they become lumpy. When in just the right condition of moisture they work up nicely, this condition is easily learned by experience.

The stony soils of the mountains of Western Maryland are producing the finest kind of fruit and there is no question of their adaptability to apple culture.

Almost all of the well drained soils of the State will produce good apples so far as the soil itself is concerned, but local conditions may make certain areas unfavorable for orchard purposes.

IMPROVING SOILS.

It is, of course, best to use soils which are fertile and in good tilth when the trees are planted, but thin and infertile soils may be used if necessary in order to save time if the trees are well fertilized while the ground is being improved. The first thing to do is to get vegetable matter into the soil, and without large quantities of stable manure this is best done with the clovers, cowpeas, soy beans, etc., the nitrogen gathering or leguminous crops. Beginning in August the ground should be well prepared and fifteen to twenty pounds of crimson clover seed per acre be sown if the soil is not too impoverished to grow clover, but in case it is, then one bushel of rye per acre should be sown instead. The resulting crop should be plowed under about May 1, and one bushel of cowpeas per acre sown at once. This crop should be plowed under early in August and crimson clover seeded immediately.

If this plan can be followed for two or three years the ground will be wonderfully benefitted, and if some commercial fertilizer can be applied twice a year when the seeding is done, the benefit will be much increased. The following amounts per acre broadcasted will be decidedly beneficial: 75 to 100 pounds of muriate or sulphate of potash, 200 to 250 pounds of acid phosphate or dissolved bone, and 50 pounds of nitrate of soda or sulphate of ammonia.

If stable manure is available it may be used as generously as the supply will warrant, but it should be remembered that too much growth is as bad as not enough and results in fruit of abnormal size and poor color and entails excessive pruning to keep trees within bounds.

In case the trees are planted when fertility improvement begins, about two pounds of the above mixture of fertilizers should be worked into the soil around each tree each spring.

EXPOSURE AND AIR DRAINAGE.

Of these two important items in apple culture, the latter is probably more exacting in its requirements than the former.

Except in the mountainous district of Western Maryland and the rolling sections near the Pennsylvania line, there is not much choice regarding exposure and the air drainage is not always as good as desired. This applies to the flat lands not very much elevated above sea level. On these lands the deficiency in air drainage must be offset by the practice of orchard heating as is done in the West.

On the rough rolling lands, the exposure does not perhaps matter much except that abrupt broad slopes straight north or south are not so desirable as others. The northwestern, western and southwestern exposures are no doubt somewhat preferable to the northeastern, eastern and southeastern in case the slopes are steep and long, but the difference in choice would be slight on gentle slopes. The two points which must be considered are, the outlet for air drainage and the absence of coves of cold air. A free outlet allowing the cold air to be carried away from the lowest points of the orchard is necessary. Cold air being heavier than mild or warm air, settles and slides down grade much like water does. If there is no outlet the coldest air sinks to the lowest places and results in late spring frosts and early fall frosts. Hollows or coves on the slopes should be avoided for this very reason. The slope must let the cold air roll off.

It may seem strange that fruit trees on a cold ridge in the mountain district will often fruit better and more regularly than trees in the warmer valleys. The reason is that the air on the ridge is more uniformly cold and remains so until late in the spring and the fruit buds are late in opening thus escaping late frosts.

In the valleys the temperature is changeable from mild or warm to cold. A few mild days in early spring often cause the fruit buds to swell or even to open and when in this tender condition a late frost easily ruins them.

WATER DRAINAGE.

The question of soil or water drainage can only be considered in a general way. Apple trees cannot stand wet feet and the ground must be well drained or used for other purposes. Surface drains will usually take care of the surplus water, but tile drains will do it better in many instances. Tile draining is expensive, but is recommended if it can be afforded.

On steep slopes the washing of the soil by surface water can usually be prevented by furrows or unplowed strips following the contour of the ground. These arrest the rapid downward flow and cause much of the water to soak into the ground. This will be mentioned under cultivation.

PREPARATION OF LAND.

After a choice of location for the orchard has been made, the ground should be plowed as deep as practicable, using a subsoil plow if possible, and worked into fine condition. The subsoil ought to be broken up a foot and one-half or two feet deep, but this is seldom done. Sometimes for special reasons, only the tree row strips are plowed leaving the middles to be worked up later.

ORDERING TREES.

After the fruit grower decides definitely what varieties he will plant, he should write to the nearest reliable nurserymen asking if they can furnish the varieties desired and at what price. He should state the number of trees of each variety wanted, the age, and size or grade, and specify definitely that under no condition will disease or insect infested trees be accepted, nor will the substitution of varieties or grades be countenanced unless by mutual agreement. A definite bargain should be made so that both sides know exactly what has been agreed upon. It is well to save the bill of sale and the correspondence for future reference, for the Court of Appeals* in New York State has decided recently that nurserymen may be sued for damages resulting from the substitution of varieties.

It would be well for fruit growers to deal direct with nurseymen rather than to depend on tree agents unless the agent is known to directly represent a reliable firm. Nurserymen are more responsible than agents. While there are some reliable tree agents there are also many unreliable ones scouring the country with gaudy lithographs of imaginary fruits and selling all kinds of varieties at high prices for any and all sections. It has been a customary practice for unreliable tree agents to fill orders of many varieties from a pile of trees of a single variety. This is a simple matter, a tree label does it.

AGE AND KIND OF NURSERY TREE FOR PLANTING.

The writer prefers above all others a well grown one-year old budded tree. A one-year old tree may be headed low and the first crop of branches may be used for the foundation branches, selecting those best placed. Nurserymen usually cut these off in growing higher headed trees. Unless a two-year old tree has been headed low in the nursery it is usually necessary to force the development of new foundation branches low on the trunk and these are not always well placed. Furthermore, a one-year old tree is cheaper than a two-year old tree.

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*Rural New Yorker, December 25, 1909, pages 1102 and 1110 and January 15, 1910, page 56.

Budded trees are preferable to root grafted ones because root grafting induces the development of crown gall. The necessary cuts made in root grafting prove easy points of infection for the spores of this disease. If nurserymen would bind cloth around the union in root grafting, there would be less damage from this source. If the roots of budded trees are injured by cultivation, or otherwise, the spores of crown gall are likely to enter and cause the disease. Trees affected with crown gall or hairy root should never be planted, they should be destroyed at once.

Spring or Fall Planting.

Except in the very coldest parts of the State, fall planting is undoubtedly best for several reasons. If the planting is done then it is out of the rush of spring work; the weather is usually pleasant in November or early December; the trees get an earlier start into growth in the spring; and the danger of other work or bad weather delaying spring planting is overcome.

If spring planting can be done early it is entirely satisfactory and late planting is better than no planting at all. The point is to do the planting in the fall or early in the spring.

Distance Apart to Plant the Trees.

Most of the Maryland soils will grow good large trees, and forty feet apart each way is about the right distance for planting, thus requiring twenty-eight trees to the acre. These are the permanent trees and since it will be many years before they will require all of the ground a temporary tree, or filler, should be set between each two permanent trees in every row and a filler row between each two permanent rows. This arrangement makes the rows twenty feet apart each way and requires 108 trees per acre, (see fig. 1).

Laying Out the Orchard.

Any one of several methods is satisfactory for laying out the orchard. the simplest is to set tall stakes twenty feet apart along both sides and across the middle of the field and plow straight furrows between the stakes. Cross furrows are made in the same way. A little digging out is needed where the furrows intersect and the trees may be planted. By sighting along the row, if aided by one or two stakes, the trees may be lined up fairly well.

Another method is to set stakes twenty feet apart across the sides of the field and stretch a wire with markers twenty feet apart between opposite stakes. A small stake is driven down at each marker to locate the position of each tree. Holes are dug and trees are lined up

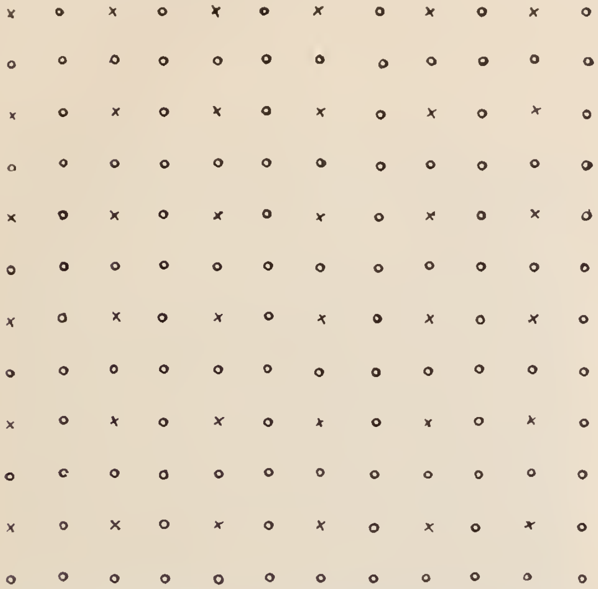

Fig. 1.—Laying out an orchard. Permanent trees are represented by x. Filler trees are represented by o.

by sighting along and across the row, but this method requires a man or two extra to do the sighting.

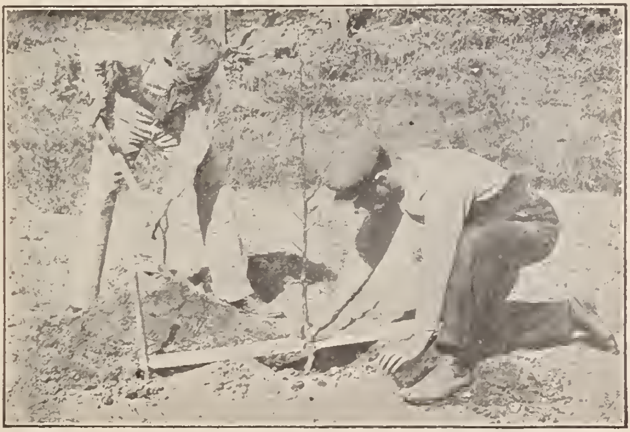

Fig. 2.—The planting board in use. (After Waugh in The American Apple Orchard).

A planting board made by cutting a deep notch in the middle and one near each end equally distant from the centre, is convenient. A board three or four inches wide will answer the purpose. The centre notch is placed against a stake marking the location of a tree. Then another stake is driven in each end notch and the centre stake and board are removed. The hole is dug and the planting board is replaced against the end stakes. The tree is set in the centre notch and the earth is filled in to hold it in place. (See fig. 2).

PRUNING TREES FOR PLANTING.

Some fruit growers prefer to have trees with long roots and others prune off all side roots leaving only the main stub root. (The latter is the Stringfellow method of stub pruning). A long root is useless and undesirable and the stub root cannot be generally advocated. A happy medium of three or four inches is strongly recommended for general use. Prune off all injured roots and cut the others back to

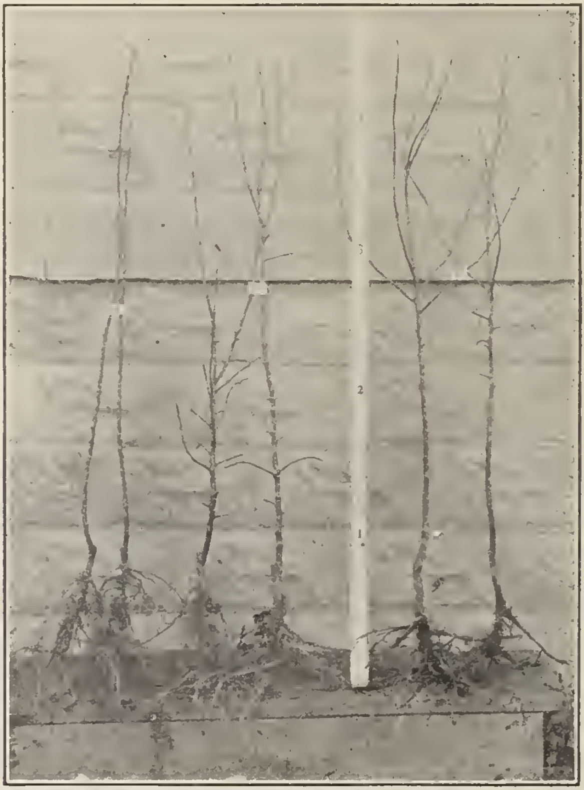

Fig. 3.—No. 9—shows two 1-year old budded trees.
No. 10—shows two 2-year old low branched budded trees.
No. 11—shows two 2-year old higher branched budded trees.
All are Stayman Winesap trees just as they came from the nursery. (Photo. by Ballard).

three or four inches in length. The end of every root should be a smooth cut. Throw out all diseased trees.

The top may be pruned before the tree is planted or immediately after, the latter being preferable. Select from three to five branches distributed around the trunk at different heights to form the foundation branches. Cut these back to from four to six inches in length.

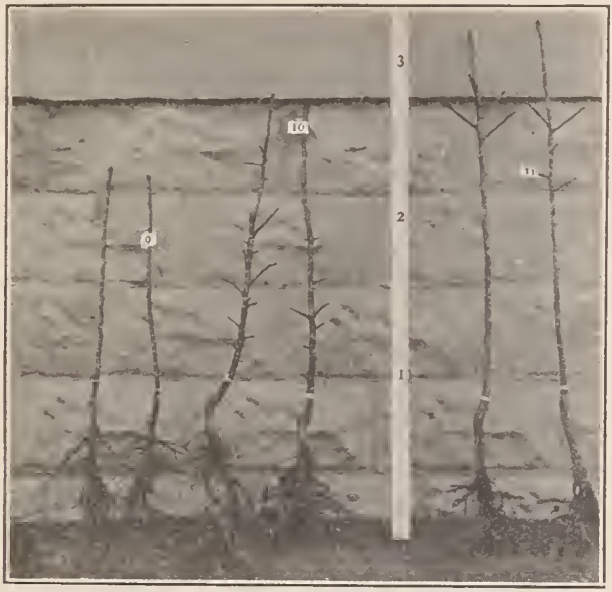

Fig. 4.—The same trees shown in fig. 3 but trimmed for planting. No. 9 are headed at 18 inches, No. 10 at 2 feet and No. 11 at 2½ feet. The white string above the roots shows how deep the trees should be planted in the orchard. (Photo. by Ballard).

Cut the other branches above the second or third bud rather than short up to the trunk. This promotes the development of more leaf surface which induces increased growth instead of leaving trunk wounds for the weakened tree to heal over as is done in close pruning. If the tree is to be low headed the top should be cut off one and one-half or two feet above the ground, if high headed at about four feet from the ground. Low heading is especially recommended. Figures 3 and 4 show one and two year old trees before and after being pruned for planting.

ADVANTAGES OF LOW HEADING.

Fortunately, the old style of high headed apple trees is going out of favor with progressive fruit growers, and the common sense method of low heading is taking its place. There are really no disadvantages with low headed trees if they are properly pruned each year as mentioned under "Pruning Young Orchard Trees." The limbs will be short and stout and ascend obliquely so as to be out of the way of orchard implements, especially the extension implements.

The low headed trees have the advantage of high headed ones in being easier and cheaper to spray, prune, and gather fruit from, and in less injury to dropped fruit and less injury by storms. The fruit will color and ripen as well on low trees as on high ones. Fruit growers should demand low headed trees from nurserymen.

PLANTING THE TREES.

In mellow and well prepared soil the hole need be only wide and deep enough to receive the tree easily. In hard ground or sod it should be three feet or more across and deep enough to set the tree two or more inches lower than it stood in the nursery (see fig. 4). Under such conditions it is often advisable to use dynamite to loosen up the soil. This is cheaper and more effective than digging and trees respond well to such treatment. Hold the tree in position, shovel in the mellow top soil, "joggle" the tree up and down slightly to settle the earth around the roots, tramp or pack the earth firmly around and over the roots, fill up the hole, pack well and throw a little loose earth on as a mulch to retain moisture. In carrying the trees from hole to hole they should be wrapped in wet burlap or other material to prevent the roots from drying out.

HEELING IN TREES.

If trees cannot be planted as soon as they are received from the nursery they should be heeled in at once. This consists in digging a trench in which to stand or recline the trees and shoveling earth over the roots and part of the trunks. This shoveling opens up a new parallel trench into which more trees may be placed and covered.

If trees are heeled in during the fall it is well to point the tops toward the south so the limbs will shade the trunks and prevent injury by alternate thawing and freezing in mild winter weather.

PRUNING YOUNG ORCHARD TREES.

1st year—This consists of the pruning done when the trees are planted, but if any new shoots tend to make the trees unsymmetrical the tips should be pinched off in summer to check their growth. This summer pinching of unsymmetrical shoots should be done whenever necessary in following years.

2d year—Cut out all surplus branches and prune back the foundation branches from one-third to one-half of their growth making the tree symmetrical and leaving the central leading shoot longer than the others. Avoid the formation of crotches as they are sure to split down and ruin the trees.

3d year—Prune as much as mentioned for second year. If twigs have grown on the foundation branches near the trunk do not disturb them except to cut them back to one or two buds to induce the development of fruit spurs; this may need to be done several times during the summer also. Do not let two branches cross or rub, remove one.

4th and following years—Until the trees begin to bear, the foundation branches should be cut back annually to make them short and strong to support heavy loads of fruit without breaking down. After fruiting begins not much pruning is necessary except to thin out surplus growth and keep the tree symmetrical. Prune from the top down and not from the bottom up.

In cutting or sawing a limb from the trunk or a small limb from a larger one, the cut should be made close up to the trunk or larger limb so as not to leave a stub. Wounds made by proper pruning heal over readily, but stubs are seldom healed over and they decay and lead the decay into the trunk thus weakening and injuring it.

Wounds over three-quarters of an inch across should be covered with white lead and pure linseed oil paint to prevent the exposed wood from drying out. Wounds made in May or June will heal over more quickly than those made at any other time of the year.

The Cultivating and Cropping of Young Orchards.

The writer is decidedly in favor of cultivation for the apple orchards of Maryland. The practice will need to be modified in different parts of the State for a mountain orchard cannot be handled like an orchard on level land.

If the orchard is not to be cropped its management is very simple on level or somewhat rolling land. It should be plowed in spring as soon as the ground is in good plowing condition and be thoroughly harrowed to work the soil into good tilth. Every ten days or two weeks the harrow should be run over the ground to loosen it up unless a heavy rain has packed it down in the meantime when it should be harrowed as soon as dry enough. The point is to keep a fine and loose dust mulch to prevent the evaporation of soil moisture.

This harrowing should be continued until about the first of August when as soon as weather conditions are favorable the cover crop seed should be sown. The commercial fertilizer should be applied and worked into the soil just before the cover crop seed is sown. In this way the cover crop gets the immediate effect of the fertilizer and when crop is plowed under the following spring it soon decays and makes available plant food for the trees. The cultivation for following years is about the same as mentioned for the first year.

In hilly or mountainous orchards this complete cultivation can not safely be adopted on account of the danger of serious washing away of the soil unless furrows are plowed following the contour of the land to check the washing. It may be necessary to plow strips eight or ten feet wide along the rows in spring and cultivate these until August when the middles may be plowed and the fertilizer applied and cover crop seed sown. A cover crop used successfully in Western Maryland is a mixture of crimson and red clover. The crimson clover grows rapidly in spring and after it blooms and dies down on the unplowed middles the red clover takes its place thus making a live cover until the ground is plowed in preparation for the fall fertilizer and cover crop seed.

It is a good practice to grow some early maturing hoed crop among the young trees until they begin to bear, but extra fertilizer or manure must be used for this crop so the trees will not be injured. Such crops as early potatoes, tomatoes, melons, sweet corn, and anything which is not late in maturing, are best, because late cultivation for late maturing crops may cause late growth on the trees and if this growth fails to ripen it may be winter killed.

After the trees are in good bearing the orchard ought not to be planted to any other crop yet this is done successfully if intelligently practiced and plenty of fertilizer or manure is used. Most varieties will bear some fruit five or six years from planting and usually a profitable crop is produced two or three years later. The age of bearing varies with varieties and location.

The small grains like wheat, rye and oats should never be allowed to mature in the orchard because they require so much moisture of which they rob the trees.

Care of Old and Neglected Orchard.

If the trees crowd each other, enough of them must be taken out to afford relief and let in sunlight and give free circulation of air. Long projecting branches should be cut back and all dead, badly diseased, weak, and surplus limbs be removed. The cuts should be made close up to the trunk or supporting limb so as to leave a stub, and all wounds should be painted with white lead and linseed oil.

In taking off large limbs saw upward from the lower side about one-fourth through, then saw from the top to meet the lower cut and the limbs will drop off without splitting or tearing down the bark and sapwood.

If there are diseased and hollow places in the trunk and limbs, scrape out all decay and treat the healthy interior with thick Bordeaux mixture, or copper sulphate one ounce to one gallon of water, and fill up with concrete. The old trunks will be improved by having the rough bark scraped off.

Give the orchard a liberal dressing of manure or commercial fertilizer in early spring and plow the ground about four inches deep. Work the soil into fine condition and harrow often enough during the summer to make a good earth mulch and early in August sow the cover crop seed.

Proper spraying is absolutely necessary and depends upon the kind and amount of diseases and insects present, see pages 318-320.

SOD CULTURE FOR ORCHARDS.

In a few favored localities orchards do well in sod. There must be plenty of moisture so neither trees nor grass will suffer. Usually sheep or hogs are pastured in these orchards and add considerable fertility to the soil. Hogs root up the ground more or less thus cultivating it in patches, but this is expensive cultivation. If the grass becomes large enough it is cut and allowed to lie where it falls. Sod culture is not recommended for Maryland.

MULCH CULTURE FOR ORCHARDS.

Mulch culture must not be confused with sod culture from which it differs in that not only the grass growing on the ground is cut and left to decay, but straw, rubbish, manure and other materials are added to form a heavy mulch. This is much better than sod culture but not so good as cultivation and is not recommended.

COVER CROPS.

A cover crop is a covering of plants on the ground when the tree growth is not very active, or entirely dormant. The principal uses of a cover crop are as follows: to check the growth of trees in the fall and cause them to ripen their wood; to take up soluble plant food which might otherwise leach out into the drainage in late fall and early spring; to catch the rain and conduct it into the soil rather than to let it run over the surface and wash away the loose solid, and to hold the snow to further protect the soil; to protect the ground from deep freezing; to catch soluble plant food in early spring before root action begins in the trees; to pump the surplus water out of the ground in the early spring and thus help to warm it up; and to add vegetable matter to the soil. The cover crop must be plowed under in the spring before it dries out the soil enough to affect the trees.

The humus or vegetable matter in the cover crop helps to improve the mechanical condition of the ground by loosening up the soil particles; to increase the water holding power of the soil; to provide a favorable home for soil bacteria; to furnish elements of plant food in available form; and to assist in breaking up chemical compounds of plant food which might otherwise remain unavailable. Cover crop plants may be divided into three classes; the leguminous ones or nitrogen gatherers like the clovers, vetches, alfalfa, cowpea, soy bean, Canada pea and velvet bean; the potash plants like cow horn turnips and rape, and ordinary plants like rye, oats, buckwheat and weeds.

The nitrogen gatherers are so named because special forms of soil bacteria associate with them and extract free nitrogen from the air and store it in tubercles on the plant roots. If a soil is deficient in nitrogen these bacteria form many tubercles on the roots of the plants, but if the soil is well supplied with humus and nitrogen they form fewer tubercles on the roots. This class of plants also returns large amounts of potash and phosphoric acid to the soil.

The potash plants seem to be gross feeders and take up cruder forms of plant food than the more delicate nitrogen gatherers, but store up much nitrogen as well as potash and considerable phosphoric acid.

The other class of plants is useful when enough nitrogen is stored in the ground and a winter cover only is needed. The small grains should never be allowed to ripen in an orchard.

Cover crop seed should be sown early in August if weather conditions are favorable. The fertilizer should be applied when the ground is prepared for the cover crop seed. Small seeds like clover should be covered with a very light smoothing harrow or weeder and large seeds with a heavy harrow.

Unless there is moisture enough in the soil to germinate the seeds, seeding should be delayed until rain comes. Crimson clover especially will not germinate in a dry soil. Seeding in dry soil will probably result in failure.

The following table showing the amounts of nitrogen, phosphoric acid and potash per acre in different cover crops four months from seeding, is taken from page 29 of the Delaware Experiment Station Bulletin No. 61, prepared by the writer in 1903. The amounts of fertilizers which the nitrogen, phosphoric acid and potash are equivalent to are also given.

	Cowhorn Turnips	Rape	Crimson Clover	Red Clover	Alfalfa	Hairy Vetch	Cowpeas	Soy Beans
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Nitrogen ..	109.5	129.4	134.4	103.0	95.2	121.2	69.5	140.2
Equivalent to Nitrate of soda (16%)	684.2	808.8	840.0	643.8	595.0	757.5	433.4	876.2
Phosphoric Acid	26.0	46.9	61.2	29.0	21.6	27.2	18.9	40.2
Equal to Acid Phosphate (14%) ..	185.7	335.0	437.1	207.1	154.3	194.3	135.0	287.1
Potash	142.6	161.3	88.2	56.4	41.7	85.5	49.8	48.0
Equal to Muriate of Potash (50%) ..	285.2	322.6	176.4	112.8	83.4	171.0	99.6	96.0

This table shows the enormous amounts of nitrogen in the different cover crops ranging from the equivalent of 433 pounds of nitrate of soda (16%) in cowpeas to 876 pounds in soy beans. Crimson clover contains the equivalent of 840 pounds and rape 808 pounds of nitrate of soda. All of the crops are high in nitrogen.

Phosphoric acid is also abundant varying from the equivalent of 135 pounds of acid phosphate (14%) in cowpeas to 437 pounds in crimson clover.

Potash is not quite so plentiful, but runs from the equivalent of 83 pounds of muriate of potash (50%) in alfalfa to 322 pounds in rape.

The plant food in one acre of this crimson clover equals the following mixture:

840 pounds nitrate of soda.
437 pounds acid phosphate.
176 pounds muriate of potash.

The crop of rape equals:

808 pounds nitrate of soda.
335 pounds acid phosphate.
322 pounds muriate of potash.

All of the other crops are also high in plant food.

AMOUNT OF SEED PER ACRE.

The different clovers should be sown at the rate of 12 to 20 pounds of seed per acre; hairy vetch 40 pounds per acre; cowpeas and soy beans 1 to 1½ bushels per acre; cow horn turnips 1 to 2 pounds per acre; dwarf Essex rape 8 to 10 pounds per acre. Combinations of various kinds may be made using one-half the amounts of seed just mentioned when two kinds are used together, one-third of each kind when three are used, etc. Crimson clover 10 pounds and cowhorn turnips 1 pound, make one of the very best combinations.

Crimson clover is the best cover crop because it lives over winter and adds so much available plant food and humus to the soil, Cowpeas and soy beans are killed by the first hard frost. Hairy vetch and red clover are hardy. Rape and cowhorn turnips die down during the winter, but many of the roots send up seed stalks in spring.

If it is desired to have a summer cover crop, the best practice is to sow cowpeas in rows and cultivate them occasionally. The tops may be cut for hay and the stubble plowed under in August.

FERTILIZERS AND MANURES.

It is impossible to say what is the best fertilizer to use because it all depends on the age and condition of the orchard, the kind of soil and the treatment it has had for several years. Some soils are rich in potash and deficient in phosphoric acid and others are just the reverse. Stable manure in large amounts is always acceptable unless the trees are making a rank growth. Cover crops add much plant food and vegetable matter to the soil and are necessary. Commercial fertilizers are depended upon to supply what is still needed.

If it is a correct supposition that the amount of plant food necessary for bearing trees can be determined from chemical analyses of the fruit, leaves and twigs computed on the total amount of fruit, leaves and wood growth made per year, then many fruit growers have been using unbalanced fertilizers with too much phosphoric acid. The writer has endeavored to get at this question from the standpoint of the amount of plant food in the fruit and leaves on trees producing five bushels of fruit each, and the indications are that the amounts of nitrogen, phosphoric acid and potash required for 108 trees per acre are equivalent to the plant food in 440 pounds of nitrate of soda, 100 pounds of acid phosphate, and 160 pounds of muriate of potash per year. Four hundred and forty pounds of nitrate of soda, or its equivalent per acre, is such an excessive amount to apply, and since a cover crop will furnish much of this about 200 pounds per acre will be considered standard here as explained below. In other words then, trees producing five bushels of apples will need about the equivalent of two pounds of nitrate of soda, one pound of acid phosphate and one and one-half pounds of muriate of potash per tree annually. Trees yielding from seven to eight bushels of fruit will need one-half more than the above amounts and those yielding ten or fifteen bushels each will need two or three times as much. Trees with larger yields will need proportionately more fertilizers. This is based on the analysis of fruit and leaves reported in table V, page 535, Cornell bulletin, No. 103. No accurate estimate can be made of the plant food necessary to make and mature the wood growth of top and roots each year although on page 538 of the same bulletin two tables indicate that for an old and not well cared for apple tree, the amount of nitrogen and phosphoric acid in leaves and one year's growth of twigs is about equal, and the potash is one-half as much in the limbs as in the leaves. If it is desired to apply plant food to supply that probably needed for twig growth the following amounts or their equivalents per tree should be added to that mentioned above: one pound of nitrate of soda, one-half pound of acid phosphate and one-half pound of muriate of potash.

Cover crops add large amounts of plant food to the soil and thus help to reduce the expense of fertilizers. In some cover crop work conducted by the writer in 1902-3 and reported on page 29 in bulletin No. 61, of the Delaware Experiment Station, crimson clover four months old produced per acre 134.4 pounds of nitrogen equal to 837 pounds of nitrate of soda, 61.2 pounds of phosphoric acid equal to 510 pounds of acid phosphate, and 88.2 pounds of potash equal to 176.4 pounds of muriate of potash. Not all cover crops will do as well as this one, but on the strength of doing something the total of 440 pounds of nitrate of soda mentioned above was reduced to about 200 pounds.

If a regular system of fertilizing and cover cropping is followed, the fertilizer ought to be applied when the ground is fitted for the cover crop seed early in August. In other practices it should be applied early in spring.

From the above discussion the following amounts of fertilizers are suggested for practical use with the understanding that the fruit grower must vary them according to the needs of his land, using larger amounts of those in which his land seems to be deficient.

Fertilizer per year for tree producing five bushels of apples.

Formula I	2 to 3	pounds nitrate of soda (16%) or its equivalent.
	1 to 1½	pounds acid phosphate (14%) or its equivalent.
	1½ to 2	pounds of muriate of potash (50%) or its equivalent.

Fertilizer per year for tree producing ten bushels of apples.

Formula II	2 to 3	pounds nitrate of soda (16%) or its equivalent.
	2 to 3	pounds acid phosphate (14%) or its equivalent.
	3 to 4	pounds muriate of potash (50%) or its equivalent.

Fertilizer per acre per year, trees 20 feet apart (108 per acre) producing 5 bushels of fruit per tree. Fewer trees per acre need correspondingly less fertilizer.

Formula III	216 to 324	pounds nitrate of soda (16%) or its equivalent.
	108 to 162	pounds acid phosphate (14%) or its equivalent.
	162 to 216	pounds muriate of potash (50%) or its equivalent.

Fertilizer per acre per year, trees 20 feet apart (108 per acre) producing 10 bushels or more of fruit per tree. Fewer trees per acre need correspondingly less fertilizer.

Formula IV	216 to 324	pounds nitrate of soda (16%) or its equivalent.
	216 to 324	pounds acid phosphate (14%) or its equivalent.
	324 to 432	pounds muriate of potash (50%) or its equivalent.

Ton lots of fertilizer in the proportion given in formulas I, II, III and IV. Use 486 pounds per acre (108 trees, on trees producing 5 for bushels of fruit each and proportionately more or less for trees bearing more or less fruit.

Formula V
888 pounds nitrate of soda (16%) or its equivalent.
444 pounds acid phosphate (14%) or its equivalent.
668 pounds muriate of potash (50%) or its equivalent.
——
2000

The per cent of plant food in all of these formulas (except II and IV) is the same, namely 7 per cent nitrogent, 3 per cent phosphoric acid and 17 per cent potash.

It will be noticed that the amount of nitrate of soda or its equivalent is not doubled in formulas II and IV. The reason for this is the high expense of nitrogen and the desire to have cover crops grown to supply nitrogen.

For young trees bearing less than five bushels of fruit each, the amount of fertilizer required is about one-fifth of that mentioned in formula I for each bushel of apples borne. Younger trees should receive from one-half pound to one pound each of the mixture given in formula I.

The kinds of fertilizers mentioned in the formulas are given to illustrate what is required, but need not be used if the fruit grower prefers other sources of plant food. In fact, it would be better to supply part of the nitrogen in tankage, ground fish, or something else, rather than to use nitrate of soda alone. The same is true with respect to phosphoric acid and potash.

The amounts of nitrogen, phosphoric acid and potash in different cover crops are mentioned under "cover crops" on page 229.

PRUNING.

Pruning may be done at any time during the year, but some seasons are better than others for this purpose. The bulk of pruning is done during the winter and spring because there is time to do it then and the results are usually good. Pruning wounds will heal quickest if made in May or June.

Careful summer pruning is of immense importance because the new growth can be so easily guided and controlled. Young trees ought to be examined every three or four weeks in the growing season when much of the pruning can be done by pinching out new growth with the thumb and finger where necessary.

It sometimes happens that young trees grow so vigorously they do not begin to bear fruit for several years after they should be producing profitable crops. This tendency toward wood production can often be checked and fruit production induced by rather severe pruning early in June.

One of the most common mistakes is to prune from the bottom up instead of from the top down. Leaves and fruit spurs should be encouraged to form on the main limbs of young trees and be left there. Many of the twigs which form on these limbs may be changed into fruit spurs by cutting them back to one or two inches in length several times a year. Old trees cannot be brought back to this condition, but the main limbs ought not to be kept as smooth as a telephone pole ten to fifteen feet high as is so often the case.

Some of the details of pruning were mentioned on pages 278 and 279.

PRUNING ACCESSORIES.

For cutting limbs too large for the pruning shears, a pruning saw should be used. There are several types of good narrow bladed pruning saws on the market. The ax is not a pruning tool yet some people mistake it for such and use it accordingly with bad results. A pruning knife makes a better cut than the hand pruning shears because the latter bruises one side of the limb at each cut, but it can be used so much more rapidly that it is preferable to a knife. The long handled pruning shears are especially useful.

Ordinary step ladders or other similar kinds are better than those which rest against the tree and bruise or break the bark. In climbing through a tree care should be taken not to skin the limbs. All skin breaks should be painted like pruning wounds.

One or two horse wagons are often equipped with high boxes with movable extension planks at each end so the pruner can reach the limbs to be removed. Two men can work very rapidly on one of these rigs.

PROPAGATION.

The apple is propagated by grafting or budding on seedling stocks. The seeds are planted in well prepared seed beds and the seedlings are dug in the fall and are heeled in or so handled that the roots keep moist either in sand, moss or other material.

Root or bench grafting is done during the winter and the grafts are planted in the spring about eight inches apart in nursery rows four feet apart.

The seedlings to be budded are planted in nursery rows in the spring like root grafts and are shield budded in August or September when the bark peels readily.

GRAFTING AND BUDDING.

The two principal kinds of grafting used on the apple are the whip or tongue method and the cleft method. The whip or tongue method is used in root or bench grafting seedling roots and in top grafting young trees. (See figs. 5 and 6).

The roots and limbs to be grafted are known as "stocks" and the pieces of twigs or grafts three or four inches long which are placed on the stocks are "cions." Cions are always made of the past season's growth. Top working means to graft or bud the top of a tree.

In whip or tongue root grafting, the cion and stock are trimmed exactly alike. A smooth slanting cut is made across one end and a backward cut near the bark and parallel to the long side is made to form the tongue as shown in fig. 5. These ends are pushed tightly together crossing them slightly so the light colored layer of bark of the cion must come in contact with the light colored layer of bark in the stock for it is here that the healing between the two takes place. The point of union is wrapped with wax cord to hold the cion and stock together and the grafts are packed away in moist sand, earth or moss for spring planting. If cloth is wrapped and tied over the point of union there will be less development of crown gall as mentioned elsewhere.

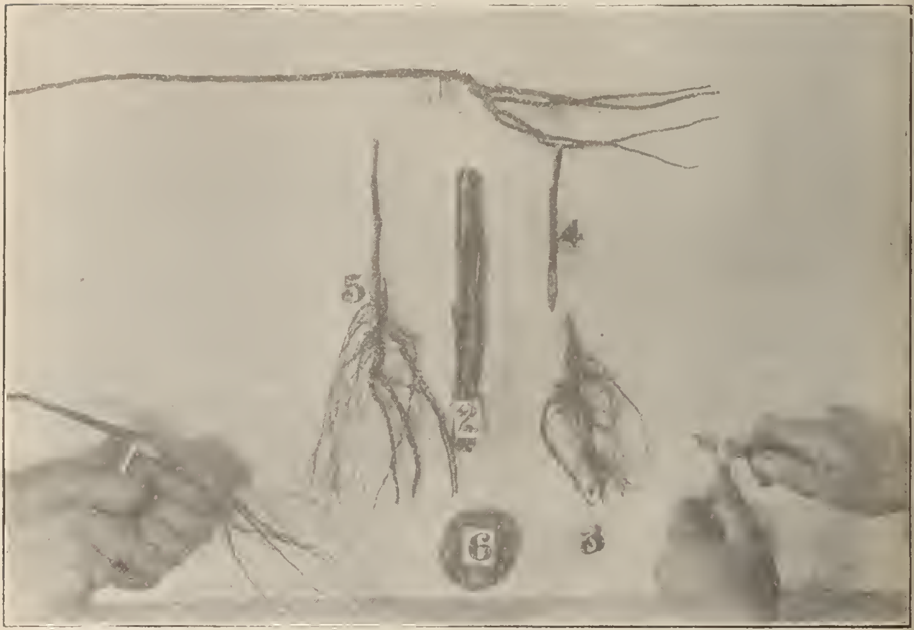

Fig. 5.—1—seedling apple stock. 2—cions. 3—the root prepared for whip grafting. 4—The cion prepared. 5—the stock and cion united. The hands show how to make proper cuts for whip grafting. (From bulletin No. 92).

Top grafting by the whip or tongue method is done just like root grafting except that the cions are grafted on limbs cut back to about three inches and all cut places are well covered with grafting wax. All top grafting is done in the spring and the scions must be perfectly dormant.

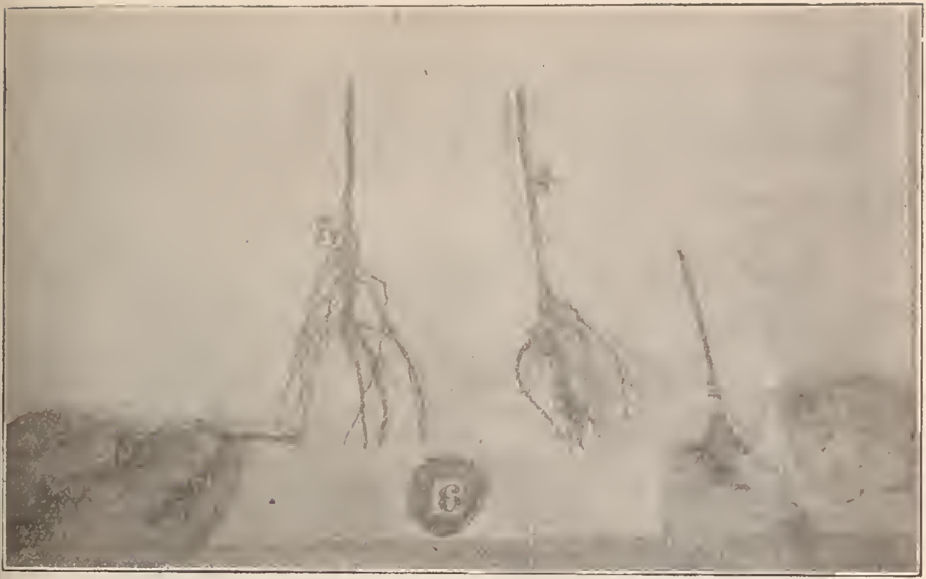

Fig. 6.—4 and 5 are the same as 4 and 5 in Fig. 5. The lower right hand corner shows the waxed cord wrapped around the union. (From bulletin No. 92).

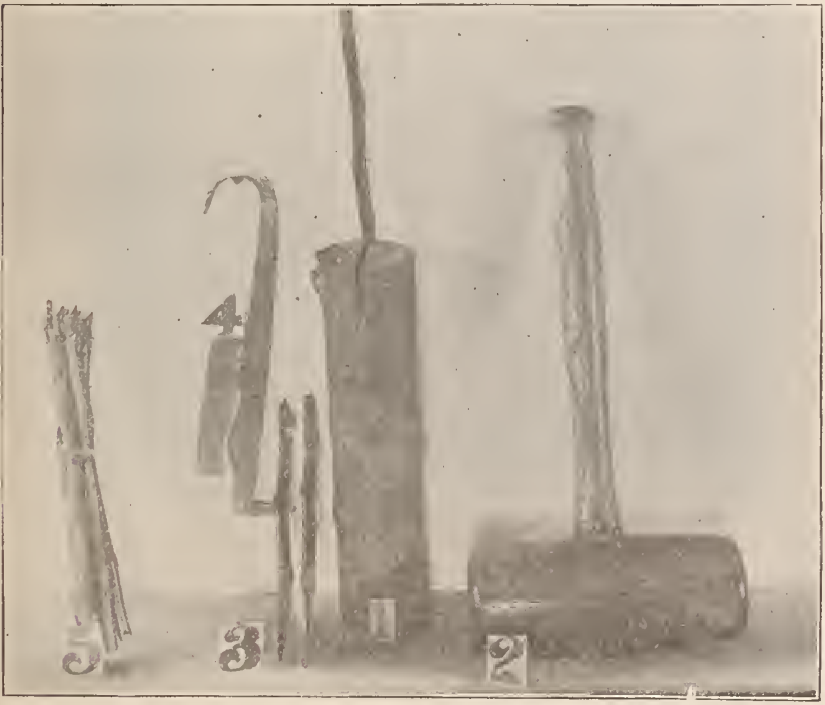

Fig. 7.—1—cleft in limb and graft set in place. 2—grafting mallet. 3—Two cleft grafts trimmed for use. 4—grafting chisel. 5—bundle of cions. (From bulletin No. 92).

In cleft grafting the cion is trimmed to a wedge shape with one side a little thicker than the other (see fig. 7) so that when it is set in the cleft, with the thick edge out, the pinching of the cleft will hold it in position. It must be placed so that its white layer or bark comes in contact with the white layer of bark of the stock, crossing these a little is best. The limb is sawed off and trimmed smoothly and the cleft or split is made with a grafting chisel as shown in fig. 7. In limbs more than one and one-half inches in diameter it is best to insert two cions, one at each side of the cleft. If both grow one may be cut out after a year or two (see fig. 8). All cut surfaces must be well covered with grafting wax.

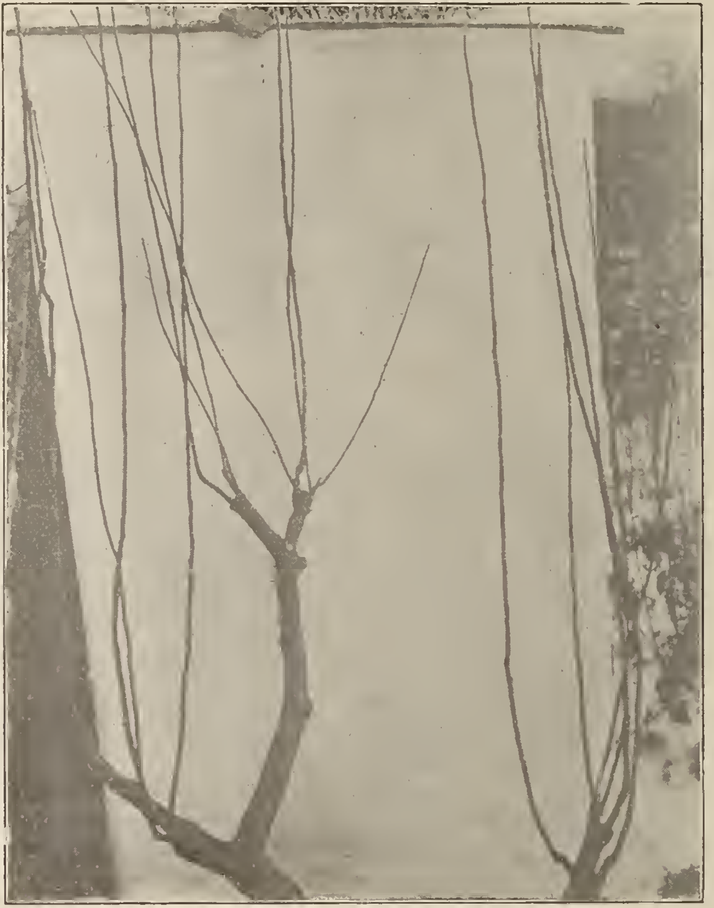

Fig. 8.—One year's growth from cleft grafts, two cions in each cleft. (From Bulletin No. 92).

Budding is done in June or September when the bark peels readily. "Bud sticks" are twigs of new growth with the leaves cut off leaving half an inch of the leaf stems. The leaves must be removed as soon as the bud sticks are cut from the tree to prevent drying them out and they must be kept in a moist wrapper.

Shield budding is done as follows: make a T-shaped cut in the bark of the stock where it is desired to place the bud. Take the bud stick in the left hand with the butt pointing downward or outward, begin cutting half an inch below the bud and run the knife beneath it and half an inch above. Take hold of the leaf stalk and slip the bud into

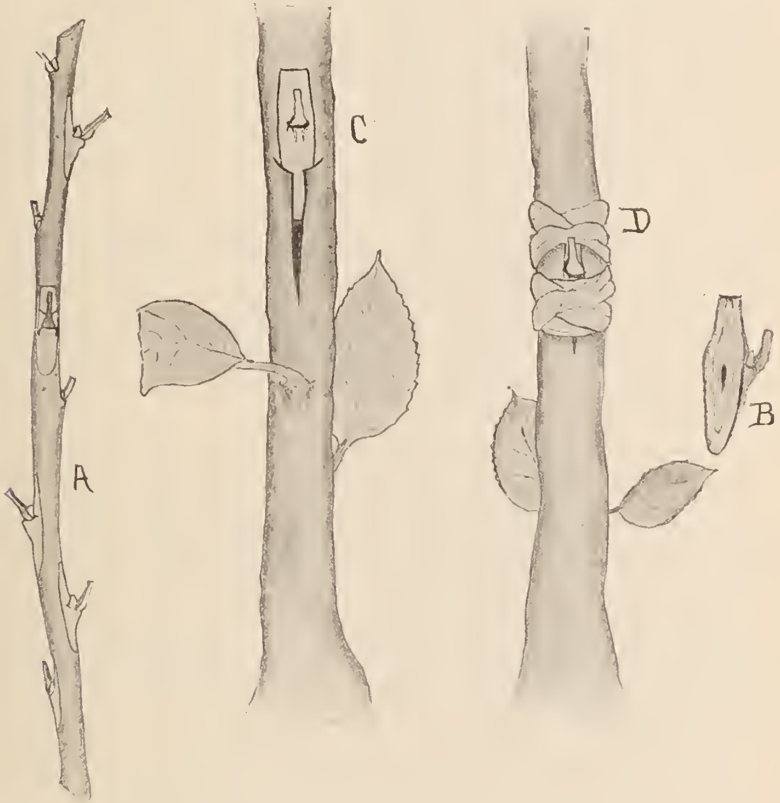

Fig. 9.—A—Bud stick showing how to cut the buds.
B—Bud ready for use.
C—The T-shaped cut in the stock and bud partly inserted.
D—The bud in place and wrapped.

(Drawing by Ballard.)

Grafting Wax.

the T-shaped cut on the stock and wrap tightly with moist raffia or coarse soft cord (see fig. 9).

About ten days after budding has been done, the wrapping is cut with one slip of the knife on the side opposite the bud. The September buds remain dormant until spring when the stock above the bud should be cut away to allow only the inserted bud to grow. When June budding is done part of the stock above the inserted bud is cut away at once and the balance later when the bud begins to grow.

Grafting wax is made of 4 parts rosin, 2 parts beeswax and 1 part tallow. Melt the rosin and let it simmer a few minutes then add the beeswax shaved fine. Let these simmer a few minutes, add the tallow and after a few minutes boiling pour into cold water. Grease the hands with tallow and work and pull the wax like molasses candy is pulled until it takes on a smooth elastic grain like rubber gum. Mould into balls or sticks and wrap in greased paper.

If the weather is cold when grafting is done the grafting wax must be kept in a bucket of hot water to make it soft and flexible. The one who uses the wax must have his hands well greased with tallow to prevent the wax sticking to them.

Liquid grafting wax is made by melting together one pound of white rosin and one ounce of tallow; remove from the fire and stir while pouring in slowly eight ounces of wood alcohol. Pour in bottles and cork securely. Apply with a brush.

Grafting Cloth.

Lay old calico cloth on a board or table and spread melted grafting wax on one side. Let it dry and tear into strips for use.

Grafting Cord.

Grafting cord is prepared by dipping balls of knitting cotton until saturated into melted grafting wax. Let the surplus wax drain out and the cord is ready to use.

Top Working Young and Old Trees to Other Varieties.

The best practice in starting an orchard is to plant strong growing trees like Red Astrachan, Northern Spy or Tolman Sweet, and top work with cions from the very best trees of the varieties desired. By doing this a uniform set of trees of known parentage will be secured. The top working may be by whip grafting or budding just before the trees are planted or two years later. The writer has had good success in whip grafting nursery trees and planting at once. If two-year old trees are used, from three to five grafts are necessary, but in one-year olds a single graft will suffice. If a cion fails to take, shoots will grow from the limb and one of these may be budded the following June or September thus keeping the growth symmetrical.

The knife used in preparing the cions and stocks must be kept sharp so as to make smooth cuts.

Older trees are either cleft grafted at once to change the variety, or most of the top is cut off to force out new shoots which are either budded or whip grafted, and a new bearing top is soon secured. Old high tops may be cut back in this way and new low tops grown instead. Cleft grafts one year old are shown in fig. 8.

Protection From Mice and Rabbits.

One of the best protectors is made from half inch mesh galvanized wire screen cut to the proper length and width and rolled around the trunk. If the trunks are so short that rabbits will reach above the protector then a shot gun should be used. All rubbish should be scraped away and an earth mound a foot high should be made around each tree late in the fall.

Removing Fillers.

As soon as the fillers begin to crowd the permanent trees they must be taken out. They need not be all removed at one time, but only as necessary leaving those in the squares between each four permanent trees to the last. It takes nerve to dig out bearing trees twenty years old and only first class fruit growers will do it.

Dwarf Trees.

It is doubtful if dwarf trees are profitable for commercial orchards or even for fillers among standard trees. They have their place in gardens around city, town and suburban homes and are highly recommended for such place or wherever space is limited. Those on doucin stock should be planted 10 or 12 feet apart each way. The very dwarf trees on paradise stock can be set 6 or 8 feet apart each way. So little room is required that anyone having a few square rods of land may have fifteen or twenty varieties of apples which will furnish a good home supply from the first part of July until Christmas or later.

The trees need the same care in planting that standard trees do, but should be looked after more carefully during the growing season. Dwarf trees are most satisfactory horticultural toys.

What varieties will do best cannot be stated here, but the entire "home use" list mentioned elsewhere is suggested for trial. Not all of these can be obtained in the nursery but the trees are easily top worked to whatever is desired.

Harvesting the Fruit.

The fruit should be most carefully hand picked when fully grown and well colored. The hand should grasp the apple cautiously with the fore finger at the stem and by a rolling and bending movement unjoint the stem from the fruit spur. Apples should not be grabbed and jerked off like objects for immediate destruction nor should they be shaken down or clubbed off as though they are out of place on the trees. Careless picking destroys many fruit spurs and injures the fruit by bruising. If the stems are pulled out or the skin broken or flesh bruised in any way, the fruit will not keep well and its value is reduced. Apples should be as carefully handled as eggs and be picked with stems on and without any bruising whatever.

A padded half-bushel basket with swing handle is a good receptacle into which to place the fruit as it is picked. A wire hook on the handle is convenient for hanging the basket on the limbs. Sacks tied together at the upper corner of each end and swung over the shoulder are much used, but they offer too much opportunity for bruising the fruit. The fruit grower must adopt whatever answers his purpose best. (See half bushel basket, fig. 10).

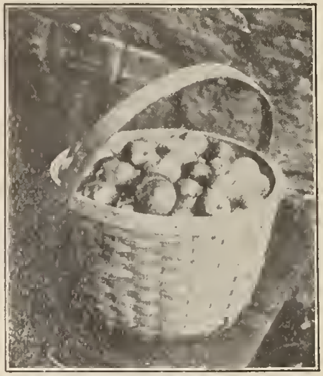

Fig. 10.—Half bushel picking basket. (After Waugh in The American Apple Orchard).

SORTING TABLES.

Sorting tables of various styles are used and one to answer the purpose can be easily made. Strong legs and side bars are necessary and

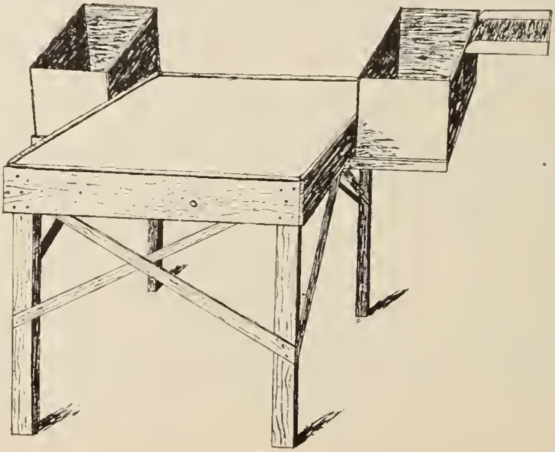

Fig. 11.—Sorting Table.

a burlap or canvas bottom is best. Some growers pick into the Delaware peach baskets and grade from these baskets without using a sorting table. A western table used in box packing is shown in fig. 11.

Grading and Packing Summer Varieties.

There are usually only two grades of hand picked summer varieties the first and second, and these differ with different growers. Some of the most successful growers, however, make as many as five grades. The first grade includes all sound fruit above two inches, or perhaps slightly less, in diameter, and the second grade includes the smaller sound fruit. Windfalls are graded the same way with respect to size.

The customary shipping package in Maryland is the bushel basket with cover. This is the same shape as the Delaware peach basket. The bushel box should be used for the choicest varieties. If barrels are used the fruit should be as carefully and properly packed as mentioned for winter apples.

Grading and Packing Winter Varieties.

The winter varieties should be divided into at least four grades—first for boxes, first for barrels, second for barrels, and culls. All first grade fruit should be two and one-half inches or larger in diameter except the small fruited varieties and with these this grade may include medium size and above. No blemished or bruised fruit is allowed in this grade. That which goes into boxes must be of fine finish, high in color and even in size. The first grade barrel stock also must be free from blemishes and bruises and ought to be of about the same size in each barrel, that is, medium and large sizes ought not to be mixed in the same barrel. This grade presents a better appearance if the apples in each barrel are nearly the same size. Second grade fruit includes that from two and one-quarter to two and one-half inches in diameter and sound and free from blemishes. The culls include all of the rest and usually ought not to be sent to market to compete with the better grades. The best culls ought to be used for evaporating and canning stock.

The very best fruit should be packed in bushel boxes as it is in the West. The commission men and city dealers advise against the bushel box for eastern fruit because there is not as much money in it for them as there is in the barrel, but nevertheless, the box should be used and forced onto them. It is certainly the coming package for fancy eastern apples. A bushel box of Peninsula grown and packed fruit is shown in fig. 12.

The standard box of the West is 10½x11½x18 inches inside measurement. This box will accommodate the commercial sizes better than a box of any other dimensions. For large apples the western growers use the California special box 10x11x20 inches inside measurement. The ends are ¾ inch thick, the sides ⅜ inch, and the top and bottom ¼ inch. There are cleats on the ends of the tops and bottoms.

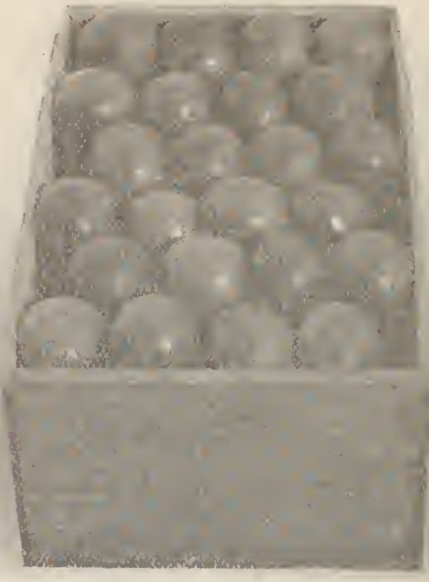

Fig. 12.—Grown and packed on the Delaware-Maryland Peninsula. (From Bulletin No. 116).

The art of packing apples in boxes is not easily described in writing, it must be learned by teaching and practice. The fruit in each box must vary but little in size and the largest must be placed in the centre to make a bulge as shown in fig. 13. When the box is packed

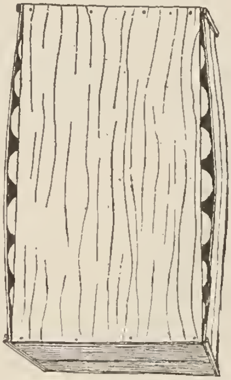

Fig. 13.—Side view of box after nailing. showing proper bulge of top and bottom.

the fruit at the ends projects slightly above the top and at the centre about an inch above. See fig. 14. When the nailing press draws the ends down for nailing, the bulge is divided between top and bottom and every fruit is held firmly in place. A packed box should be laid on its *side* and never on the top or bottom or the fruit will be bruised.

The number of apples each box contains, the name of the variety and the grower's name, should be stamped on one end of the box. A neat and attractive label pasted on one end adds to the appearance of the package and is a good investment.

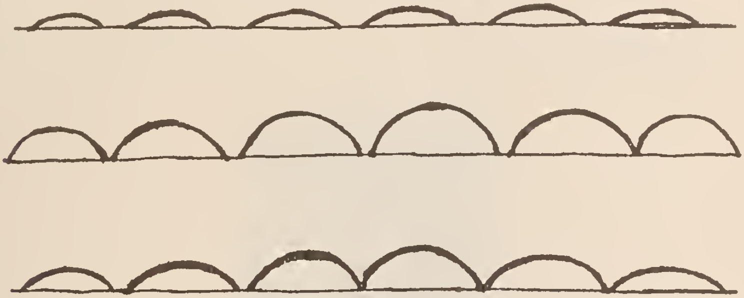

Fig. 14.—The Bulge. Top row is too flat, middle row is too high, especially at ends, lower row as it should be.

A full discussion with illustrations of apple box packing will be found in Bulletin No. 94, of the Oregon Agricultural Experiment Station, and in "Better Fruit" published in Hood River, Oregon.

The proceedings of the Fifth Annual Convention of the Fruit Growers' Association of Adams County, Pa., held in December, 1909, include a most instructive address by Mr. C. C. Vincent, Assistant Horticulturist of the Oregon Agricultural College, on box packing of apples. These instructions are so clearly given that a few paragraphs are quoted in full as follows:

"The apples, on their arrival at the packing house, are placed at the ends or in the center of the building. A crew of men begin immediately to sort the apples. I have here a sizing board (shows board about six inches wide and two feet long, with a row of holes through the center, varying in diameter from 2⅜ inches to 3⅜ inches in regular sequence), which represents the different sized apples that are put up in boxes. This board (see fig. 15) is placed up in a convenient place, before the sorters. As soon as the grader has trained his eye, and this it will not take him long to do, he will be able to discard the grading board for the most part, and can tell at a glance if a certain apple is going to fit in a certain pack. If in doubt, he holds the apple

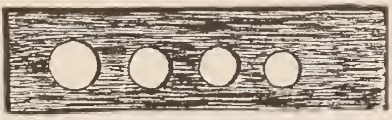

Fig. 15.—Grading Board.

up to the hole, but never drops it through. Some men, the grower finds, soon adapt themselves to this method and become very proficient graders. But, just as you have found in barreling, some men will never learn how."

STYLES OF PACKS.

"At the present time there are two styles of packs, known as the square, or straight, and diagonal pack. In the square pack the apples are placed one upon the other. In the diagonal pack (see fig. 16), there is less danger of the apples bruising in transit, as no one apple rests upon another, but fits in between the four apples below. Undoubtedly before many seasons pass, the diagonal pack will be the one most largely used. If only the two sized boxes were used, all apples could be packed diagonally. For instance all the apples that would pack square in the California box, could be packed diagonally in the Standard box. The three tier, four tier, and five tier apples will pack up in the square pack. The three and one-half tier, four and one-half tier, can be placed in the diagonal pack."

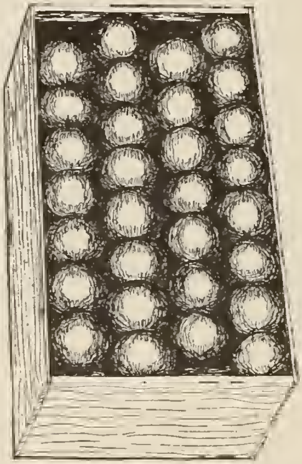

Fig. 16.—Celebrated Diagonal Pack.

"The classification of the apples contained in each box, as is designated by the tin labeling, is as follows:

3 Tier Apples in the Standard box, 45 to the box.
3 Tier Apples in the Special box, 54, 63.
3½ Tier Apples in the Standard box, 64, 72, 80, 88.
3½ Tier Apples in the Special box, 96, 104, 112, 120.
4 Tier Apples in the Standard box, 96, 104, 112, 120.
4 Tier Apples in the Special box, 128, 144.
4½ Tier Apples in the Standard box, 150, 163, 175.
4½ Tier Apples in the Special box, 185, 200.
5 Tier Apples in the Special box, 200, 225.

Unless the apples have been properly graded beforehand, no such system of classification can be obtained. Probably the best place for the 5 Tier Apples, is at the evaporator or cider factory."

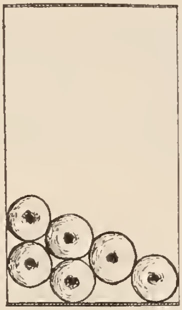

Fig. 17.—Method of starting 3½ Tier Diagonal Pack.

Starting the Packs.

"Very little trouble will be experienced in starting the square pack, i. e., if the apples have been properly graded. With the Three Tier Apple, which is three and three-eighth inches in diameter, it requires three apples to fill up the space across the bottom of the box, or in other words there will be three rows in width and three layers in depth. The Four Tier Apples require four rows in width and four layers in depth."

"The diagonal Three and one-half Tier pack (see fig. 17) is started differently. In this style one gets three and one-half rows in width and four layers in depth. The first apple is placed in the lower left hand corner of the box, another apple is placed in the center. The fol-

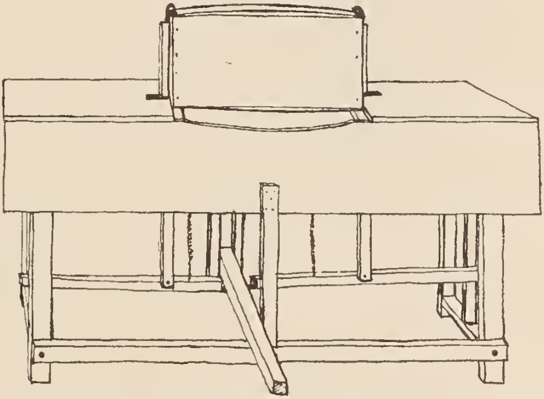

Fig. 18.—Nailing Press.

lowing two apples are pressed firmly in the places which are left. This is sometimes called the two by two pack."

"To start the Four and one-half Tier pack, place the first apple in the lower left hand corner of the box, another in the lower right hand corner, and another in the center. Two apples are then pushed down, as far as possible in the spaces that are left vacant. The Four and one-half Tier pack is also known as the three by two pack."

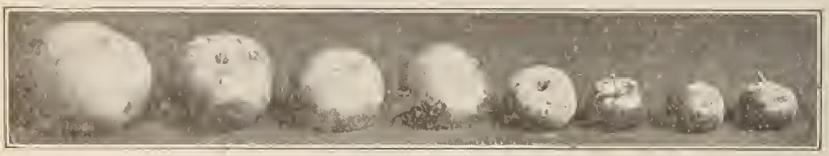

Fig. 19.—Specimens from a fraudently packed barrel of apples. (From Bul. No. 116).

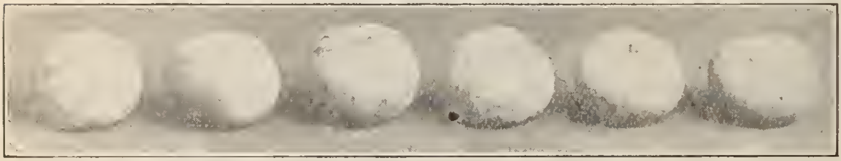

Fig. 20.—Specimens from an honestly packed barrel of apples. (From Bul. No. 116).

THE BULGE.

"Inexperienced packers will have some little difficulty in getting the proper bulge to the box. Practice, however will obviate this. When the fruit is packed, the apples at both ends should come up flush with the top. In the center they should extend a little higher. (See fig. 14). There is more or less of a gradation between one sized apple and another. For instance, between the Three Tier and Three and one-half Tier. To obtain the proper bulge, which should be from one tc one and one-half inches, the packer selects apples that are a trifle smaller for the ends, working those that are a trifle larger to the center. In case the apples are of the same size and are being packed on the cheek, in order to obtain the proper bulge, the end apples are turned with the stem ends up. Every boxful should have a swell. (See fig. 13). As soon as the box has been filled it is taken to the nailing press (see fig. 18) and the cover placed on."

THE SULZER BILL, H. R. 21480.

AN ACT to establish a standard barrel and standard grades for apples when packed in barrels, and for other purposes.

Be it enacted by the Senate and House of Representatives of the

United States of America in Congress assembled. That the standard barrel for apples shall be of the following dimensions when measured without distention of its parts: Length of stave, twenty-eight and one-half inches; diameter of head, seventeen and one-eighth inches; distance between heads, twenty-six inches; circumference of bulge, sixty-four inches outside measurement; representing as nearly as possible seven thousand and fifty-six cubic inches.

Sec. 2. That the standard grades for apples when packed in barrels which shall be shipped or delivered for shipment in interstate or foreign commerce, or which shall be sold or offered for sale within the District of Columbia or the Territories of the United States shall be as follows: Apples of one variety, which are well-grown specimens hand picked, of good color for the variety, normal shape, practically free from insect and fungous injury bruises, and other defects, except such as are necessarily caused in the operation of packing, or apples of one variety which are not more than ten per centum below the foregoing specifications shall be "U. S Standard minimum size two and one-half inches," if the minimum size of the apples is two and one-half inches in transverse diameter; "U. S. Standard minimum size two and one-fourth inches" if the minimum size of the apple is two and one-fourth inches in transverse diameter; or "U. S. Standard minimum size two inches," if the minimum size of the apples is two inches in transverse diameter.

Sec. 3. That the barrels in which apples are packed in accordance with the provision of this Act may be branded in accordance with section two of this Act.

Sec. 4. That all barrels packed with apples shall be deemed to be below standard if the barrel bears any statement, design, or device indicating that the barrel is a standard barrel of apples, as herein defined, and the capacity of the barrel is less than the capacity prescribed by section one of this Act, unless the barrel shall be plainly marked on end and side with words or figures showing the fractional relation which the actual capacity of the barrel bears to the capacity prescribed by section one of this Act. The marking required by this paragraph shall be in block letters of size not less than seventy-two point one-inch Gothic.

Sec. 5. That barrels packed with apples shall be deemed to be misbranded within the meaning of this Act—

First. If the barrel bears any statement, design or device indicating that the apples contained therein are "U. S. Standard" and the apples when packed do not conform to the requirements prescribed by section two of this Act.

Second. If the barrel bears any statement, design, or device indicating that the apples contained therein are "U. S. Standard" and the barrel fails to bear also a statement of the name of the variety, the name of the locality where grown, and the name of the packer or the person by whose authority the apples were packed and the barrel marked.

Sec. 6. That any person, firm or corporation, or association who shall pack or cause to be packed apples in barrels or who shall sell or offer for sale such barrels in violation of the provisions of this Act shall be liable to a penalty of one dollar for each such barrel so sold or offered for sale, to be recovered at the suit of the United States in any court of the United States having jurisdiction. This penalty to be recovered under the provisions of an Act approved June thirtieth, nineteen hundred and six, entitled "An Act for preventing the manufacture, sale, or transportation of adulterated or misbranded or poisonous or deleterious foods, drugs, medicines, and liquors, and for regulating traffic therein, and for other purposes." (Thirty-four Statutes, page seven hundred and sixty-eight).

Sec. 7. That this Act shall be in force and effect from and after the first day of July, nineteen hundred and thirteen.

As will be seen from the above, the use of the "U. S. Standard" is not compulsory, but the advantages accruing to the grower who does follow these specifications will go a long ways toward giving him an established and profitable trade.

Basket and Barrel Packing.

A good handle basket holding about a peck of apples ought to become a very popular retail package if it could be generally introduced. Now that the Parcel Post is an established fact, the need of small apple packages suitable to be transported by this method, is being rapidly filled by various designs which are now being placed upon the market. The survival of the fittest will soon eliminate the undesirable ones. A medium sized corrugated paper board carton will doubtless make a very satisfactory package.

The barrel will continue to be the most popular package for the eastern grower for some time to come, and properly used it is a splendid package, but unfortunately it is abused by dishonest growers and packers who fill the centre with small, wormy, diseased and worthless fruit. (See figs. 19 and 20).

To pack a barrel, take out the bottom head and stand the barrel with top head down so as to pack the top end first. Lay a corrugated paper or cushion head protector in position, cover with a fancy paper cap and place a layer of "facers" stem ends down in circular rows fitted tightly together. (See figs. 21, 22, 23 and 24). A second layer of facers is similarly placed breaking joints with the first layer. The facers are of exactly the same grade as the balance of the apples in the barrel, but are selected because of their high color. This is allowable and is expected and is not a deception. The barrel presents a better appearance upon taking out the top head if the facers are well colored. Over the facers pour very carefully about half a bushel of apples at a time and shake the barrel cautiously but vigorously each time to settle the fruit firmly together. Fill the barrel to just above the end of the staves and face the top layer stem ends up. A padded head to prevent crushing the upper fruits may now be laid on and forced down carefully before putting in the head, or the head may be placed on

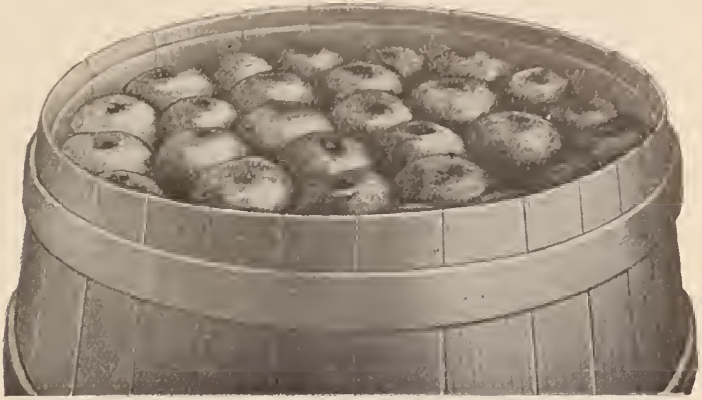

Fig. 21.—A well packed barrel of apples. (From Bulletin No. 116).

at once and be pressed down into the chine. The hoops are then driven down and the head is nailed in. The grade, name of variety and grower's name should be stamped on the top head.

The screw barrel press, fig. 25, is one of the best.

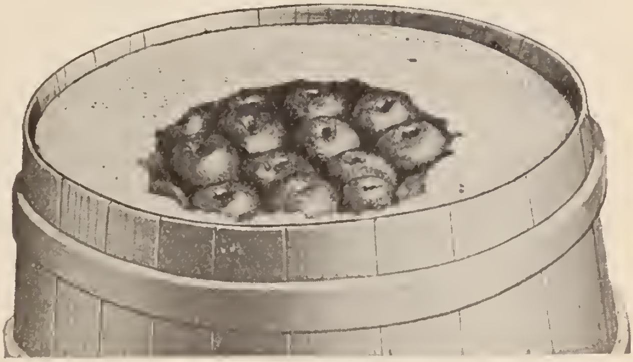

Fig. 22.—Fancy paper trimmings. (From Bulletin No. 116).

STORING APPLES.

The old custom of piling fall and winter apples in the orchard to let the sun color them has only one reason for being practiced and that is to hasten the ripening of fruit for immediate use.

Apples so handled will not keep as long in ordinary or cold storage as those packed and placed in cold storage as soon as picked. Apples will keep best if rushed into cold storage at the earliest possible moment after picking. If the grower has such a storage place at hand he can take the fruit there as soon as picked and grade and barrel at his convenience. Those who must depend on city cold storage should grade and pack at once and ship to cold storage daily if the weather is mild or warm. If the weather is cold when picking and packing are going on, less damage to the fruit will result from delayed storage.

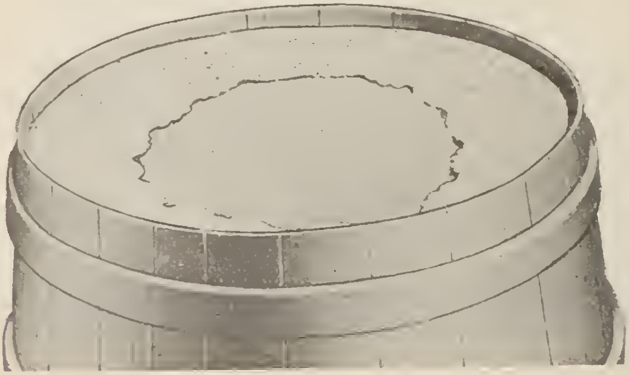

Fig. 23.—Paper cap and fancy trimmings. (From Bulletin No. 116).

Local cold storage plants for winter apples in Maryland are not at present really necessary for it is better to ship at once to city storage warehouses in the fall so the fruit may be placed on the market at a few minutes notice when the best prices prevail during the winter. This makes the fruit grower more independent than he would be if he had to ship during cold winter weather from his local storage to the city markets. Local warehouses would be very valuable, however, for holding summer apples, peaches and other fruits.

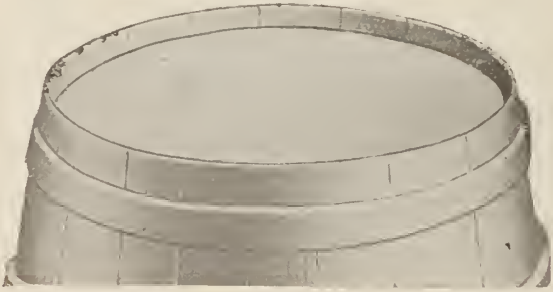

Fig. 24.—Corrugated paper cap to protect the fruit. (From Bulletin No. 116).

ORCHARD HEATING.

The next great step in progressive eastern horticulture will be orchard heating. This is practiced successfully in the inter-mountain district of the West and on the Pacific Slope. About 100 smudge pots are required per acre, these cost from 20 cents to 30 cents each. Crude oil and soft coal are the forms of fuel used. Those interested will find different makes of orchard heaters advertised in horticultural periodicals.

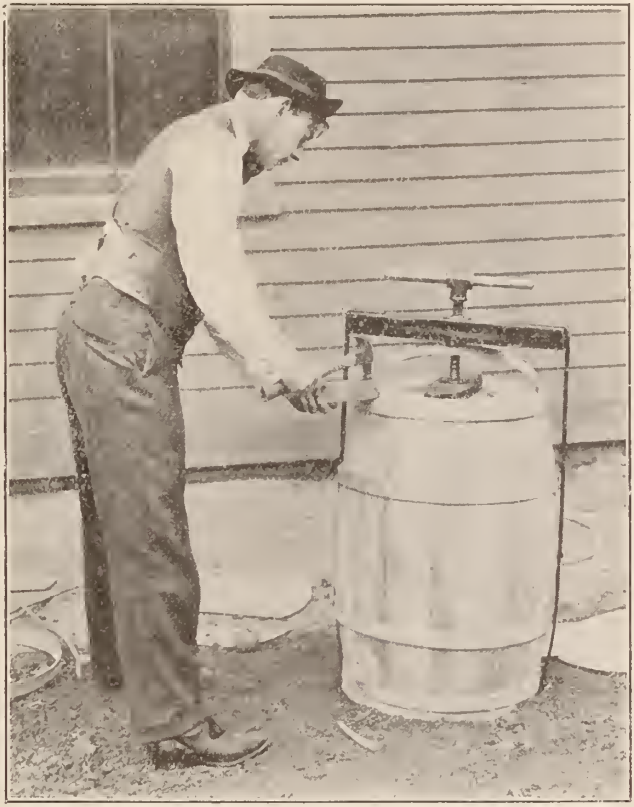

Fig. 25.—A good type of screw press used in heading apple barrels. (After Waugh in The American Apple Orchard).

SELECTING APPLES FOR EXHIBITION PURPOSES.

Until recently the largest and most overgrown specimens of apples received first premiums at the county and state fairs, horticultural society exhibitions, etc. This has now been very sensibly changed to favor commercial sizes and at the great national expositions the large specimens of a variety stand very little chance of winning a premium. Select fruits according to the following instructions:

Slightly above medium size for the variety.

Fruits of absolute uniformity in size and shape.

Fruits of typical shape for the variety.

Five fruits for an exhibition plate of apples.

Color uniform and the higher and richer the better.

A whole stem in every apple.

Entire freedom from blemishes.

The loss of a stem, a break in the skin, a disease or insect mark, bruise, frost or spray injury, these are all blemishes.

Any one of the following apparently trivial defects have caused otherwise perfect plates to lose premiums,—one apple too large or too small, one apple not quite typical in shape, the loss of one stem, a light spot where there should be solid red color, or a small disease spot or insect blemish.

The rubbing and polishing of exhibition apples should not be allowed, and cannot be too strongly condemned.

VARIETIES.

The question of selecting varieties for any locality is a serious one and mistakes cannot be made because too much depends upon the outcome of the crop. The writer will not recommend varieties low in quality without offering proper explanation because he believes that fruit growers should be encouraged to produce only the best, that consumers should be taught to use nothing but the best, and that there will be more profit and satisfaction in the long run in growing none but the best. Such varieties as Ben Davis and York are usually profitable and there are people who like them, but even admitting all of this the writer still claims that the most progressive fruit growers should plant only the best quality varieties.

It may be that some varieties grown locally are not mentioned in the following lists, however, if these are satisfactory to the grower he had better continue to grow them.

There are so many good varieties which succeed in Maryland that it is difficult to give every one proper recognition.

A general list for home use and local market would cover the entire State except Allegany and Garrett counties where a change in winter varieties is necessary. This general list follows arranged in the order of ripening:

Yellow Transparent.
Early Ripe.
Early Harvest.
Red June.
Early Strawberry.
Red Astrachan.
Williams.
Chenango (Strawberry).
Summer Rambo.
Sweet Bough.
Jefferis.
Mother.
Benoni.
Maiden Blush.

Fall Pippin.
Bailey Sweet.
Gravenstein.
Wealthy.
Grimes.
Bloomfield.
Domine.
Jonathan.
Rome.
Stayman Winesap.
Akin.
Winesap.
Nero.
Paragon

For Allegany and Garrett counties the winter varieties which have proved successful are Fameuse, McIntosh Red, Tompkins King, Twenty Ounce, Baldwin, Rhode Island (Greening), Northern Spy, Yellow Bellflower and Wagener.

Commercial lists will not vary much over most of the State except according to the taste of the grower. The farther south the summer varieties are grown the earlier they will ripen and the more profitable they will be. However, even in the northern tier of counties clear across the State these varieties are very valuable.

The group of most profitable summer varieties includes Yellow Transparent, Early Ripe, July and Williams of which the Williams usually brings the highest price. These make a succession of ripening for about four weeks. The Red Astrachan comes in with July and is popular with some growers. Its principal faults are uneven ripening and biennial bearing. The Early Harvest can be made profitable with good cultivation and spraying. Red June ought to be very profitable because of its high quality and bright red color. It attains good size where well cared for.

The next group will include Summer Rambo, Maiden Blush, Mother and Fall Pippin. These will probably not be as profitable as the first group, but are mentioned to fill in the season and will succeed in any part of the State.

Following these is another group of four of the best late fall varieties, Gravenstein, Wealthy, Bloomfield and Grimes. These are very profitable for the entire State and extend the season to the early winter varieties.

All of the varieties in the three groups just mentioned ripen in southern Maryland and the southern part of the Eastern Shore from two to four weeks earlier than in Western Maryland, but as the market demand for them is continuous they are all profitable.

There is considerable difference of opinion regarding winter varieties and much is yet to be learned with respect to their adaptability to different sections. It is best to have only three or four winter varieties rather than six or eight. For all of the State except the highest altitudes of the mountainous section, the Jonathan, Stayman Winesap, Paragon, Winesap, Rome and Nero are in the opinion of the writer the very best. These should all be given a thorough trial in the mountainous sections of the counties just mentioned where the old northern varieties like Tompkins King, Twenty Ounce, Rhode Island

(Greening), Spy, Yellow Bellflower and Baldwin are the favorites and are well adapted.

The McIntosh, Cox Orange, Delicious, Winter Banana and King David ought to be thoroughly tested throughout the northern row of counties across the entire State.

DESCRIPTIVE LIST OF VARIETIES.

During recent years no less than 151 named varieties of Maryland grown apples have been exhibited at the annual exhibitions of the Maryland State Horticultural Society. Besides these there were a dozen or more unknown varieties. If 126 of the named varieties and all of the unknown ones could be suddenly discarded and be replaced by the 25 selected varieties remaining, the apple industry of the State would be in a greatly improved condition. Brief descriptions are given of 87 varieties.

Akin—A medium sized apple of fine quality, beautifully colored, winter. Especially promising for growers desiring to cater to a fancy trade.

Alexander—A large Russian early winter apple, flattened conic, mostly red or red striped, fair quality, does well in cold sections but will probably not be extensively planted.

Arkansas Black—A medium sized winter apple, nearly round, almost solid black in color, very attractive, fair quality, hardy, winter, will not be much planted.

Bailey Sweet—Large, attractive red striped or partly solid red, good quality, sweet, good for home use or local market, late fall.

Baldwin—An old standard winter variety of medium quality probably more grown than any other variety in cold sections but not always hardy. It is of value in Maryland only in the mountainous districts.

Beach—Medium, roundish flattened, shaded and striped with red and carmine, fair, winter, not recommended.

Ben Davis—Attractive in appearance when well grown, red striped, poor quality, above medium size, good bearer, winter, is still profitable to grow but better varieties should be planted.

Beitigheimer—Very large, purple red, tart, fall variety, ripens unevenly and drops badly, not worth planting.

Benoni—A small red apple of fine quality, excellent for home use but too small for commercial planting, early fall.

Bismark—Above medium size, red striped, poor quality, very early bearer as a dwarf, not recommended, early winter.

Black Ben Davis—Much like Ben Davis except it is a little longer and smoother in outline, very dark solid red color, fragrant, not so poor in quality as Ben Davis and is to be preferred to that variety, winter.

Bonum—Medium size, dark red or striped, oblate, fine dessert apple for home or local market, annual bearer and productive, late fall.

Buckingham—Medium to large, oblate or slightly roundish, somewhat irregular, yellow mottled and striped with red and carmine, good quality, good for home use.

Chenango (*Chenango Strawberry*)—Small to above medium size, long pointed, whitish skin striped with red, good quality, very productive, ripens unevenly during a period of three or more weeks thus being especially good for home use and local market, early fall.

Colton—A small, round, greenish bronzed summer variety ripening with Yellow Transparent and Early Ripe, too small, not recommended.

Cox Orange—An old English variety, medium size or above, slightly conic, red striped, one of the best in quality, winter. This should be tested in the northern tier of counties especially in the western part of the State.

Dominie—Medium size or above, flattened or slightly conic, greenish or yellowish striped with red, good quality, productive, early winter.

Early Harvest—Medium or above in size, greenish yellow, good quality, needs spraying and cultivating, good bearer when well cared for, fine for home use, almost as early as Yellow Transparent, probably succeeds best on Eastern Shore and Southern Maryland.

Early Ripe—Medium size, flattened, hard flesh, good quality, extra good shipper and market variety, very productive and profitable, ripens with Yellow Transparent.

Early Strawberry—Small size, red striped or nearly solid red, extra good quality, fairly productive but late to come into bearing, good for home use or local market, follows Early Ripe.

English Red Streak—This is probably "Wells." Fruit large to very large, roundish slightly conic, yellowish streaked and blotched with red, good, late fall or early winter.

Esopus (*Spitzenburg*)—One of the highest in quality, often shy bearer, medium size or above, irregular in shape, roundish ovate slightly conic, red, should be top worked on a strong growing variety like Red Astrachan or Northern Spy. Good for Western Maryland, winter.

Delicious—Medium to large, attractive, red striped or nearly covered with red, conic or long drawn out with prominent knobby ribs at blossom end, ribbed, pleasant rich flavor but almost too sweet, winter. Said to succeed where Northern Spy does but should be tried throughout the entire State.

Fallawater—Large to very large, greenish sometimes with blush, poor quality, winter, not recommended.

Fameuse—Small to medium, good quality, nearly red, early winter, would do best in Western Maryland but there are better varieties.

Gano—An improved Ben Davis but a little flatter in shape and of a nearly solid red color, winter.

Gloria Mundi—A very large, irregular, yellow winter variety, not recommended.

Golden Russet—Medium size, roundish, good quality, winter, good for home use.

Gravenstein—Above medium size, flattened or roundish, mostly red or red striped, very productive, very good quality, late fall, ought to be more generally grown for market.

Green Newtown—This is similar to Yellow Newtown except that it is of a greener color, both are of high quality.

Grimes (*Golden*)—Medium to large, roundish or cylindrical, flattened at ends with large cavity and basin, yellow, one of the best in quality, late fall. The fruit should be put in cold storage and held for Thanksgiving and Christmas trade. Nursery grown trees of this variety are seldom long lived, they usually die at from 15 to 25 years of age. Strong growing varieties with healthy trunks like Red Astrachan, Tolman Sweet or Northern Spy should be planted and top worked to Grimes. This is one of the best of its season for Maryland.

Haas—Medium or above, oblate, red striped with carmine, fair quality, productive, early winter, not recommended.

Holland Winter, (Incorrectly *Holland Pippin*)—medium to large, roundish conic, whitish or pale green often with faint blush, good, late winter, productive.

Hoover—Medium to large, roundish, dark red almost black with prominent light colored dots, quality poor, not recommended.

Hubbardston—Medium size, conic, red mottled and striped, good quality, good bearer, early winter, would probably do well in Western Maryland.

Jefferis—Small to medium size, oblate, red striped, excellent quality, good bearer, especially good fall variety for home use.

Jonathan—Medium or slightly above, roundish conic or roundish ovate, light to dark red, uniform in size, rich spicy flavor, excellent quality, early winter, trees have slender twigs and grow slowly at first, productive. The writer has heard one complaint of its blighting and one of its having a tender trunk thus requiring to be top worked on a strong grower like Red Astrachan or Northern Spy. This is certainly one of the best varieties for all parts of the State except Garrett and Allegany Counties.

July—Medium to large, roundish conic, greenish or white somewhat striped with red, fairly good, tree strong grower, productive, follows Yellow Transparent in season.

King David—Medium or above in size, oblate slightly conic, dark red, good, early winter. Worth trying all over the State but may not succeed in all sections.

Kinnaird—Small to medium or above, oblate slight conic, rich dark red, good, not much grown.

Lady—Very small, yellow with red cheek, good quality, winter, grown for fancy trade and for decorations.

Lankford—Medium to very large, usually lop-sided, dull red, good quality as grown on the Eastern Shore, productive, early winter, not desirable.

Lawver—Medium to large, bright solid red, productive but drops badly, very late winter variety, fair quality but improves as it ripens in spring, keeps until July in cold storage. If a very late keeper of fairly good quality is desired this may be used.

Limbertwig—Small to medium size, dull red or striped, fair quality, late winter, productive, not recommended.

Lowland Raspberry (*Liveland Raspberry*)—This variety should be tested in Maryland, its season is about two weeks later than Yellow Transparent. The fruit is medium or above in size, roundish, waxy white with rosy red blush or stripes, very attractive, fine grained and good.

McIntosh—Medium size or above, roundish, attractive red, fine grained, pleasant perfume, very good. The tree is very hardy and should be a valuable early winter variety for Western Maryland, belongs to the Fameuse group.

Maiden Blush—Medium or above, oblate, yellow with bright red blush, very good quality, one of the best known fall market varieties.

Missouri Pippin—Small, roundish, ends sometimes flattened, often slightly oblique, rich red striped and shaded, poor, early winter, very prolific and bears early. Much used as a filler, not recommended.

Mother—Medium or above, roundish conic, nearly covered with dull red, splendid dessert variety, fairly good bearer, late fall. Ought to prove valuable for Maryland.

Nero—Medium or above, oblate, striped or nearly covered with red, fair to good quality, annual bearer and very productive of even sized fruit, winter, is one of the most profitable varieties on the Maryland-Delaware Peninsula.

Nickajack—Large, roundish, uniform in size, attractive, dull grayish—red striped, solid flesh, fair quality, very late winter, keeps in cold storage until July and then sells at high prices, trees are late to come in bearing but then bear annually.

Northern Spy—One of the old standard northern winter varieties of best quality well adapted to Western Maryland, but is of little value in other parts of the State where it ripens in the fall, drops badly and is of poor quality.

Northwestern Greening—Large to very large, roundish to oblong, slightly conic, greenish or yellow, fair to good quality, productive, early winter, tree very hardy and a good one for top working to weak varieties like Grimes.

Oldenburg (*Duchess*)—Medium size, usually flattened, attractive, red striped, splendid cooking apple because of acidity, productive, hardy Russian variety, is especially valuable for Western Maryland.

Oliver—An attractive winter apple of good size and color, quality good, tree vigorous and productive. Recommended for further trial.

Ortley—Medium to large, oblong conic to round conic, pale yellow, flesh tender, good, not recommended.

Paragon (often called *Mammoth Black Twig*)—Medium or above, uniform in size, oblate slightly conic, almost covered with dull red nearly black, late to come into bearing but is then productive, good to very good, late winter, very valuable for Maryland.

Pennock—Large, roundish flattened, dull red, fair to good, winter, not recommended.

Pewaukee—Large, roundish with cavity nearly closed, bright or dull red striped, fair quality, tree hardy and good cropper, winter, not recommended.

Ralls, (Jeniton, Ralls Janet)—Small to medium, roundish to slightly flattened or conic, dull greenish with dull red striping or solid red, good quality, very productive, should be thinned or fruit is very small, good for home use, winter.

Rambo—Medium, roundish flattened, pale yellow more or less mottled or striped with red and roughened with russet dots, very good quality, early winter, good for home use.

Red Astrachan—Medium or above, roundish, pale yellow or greenish, partly covered with red or sometimes striped, flesh tender, tart, good, ripens unevenly two or three weeks after Yellow Transparent, biennial cropper. Tree is hardy and should be used as stock for weak growers like Grimes.

Red June—Small to medium, roundish inclined to conic or oblong, often entirely purplish red but sometimes striped, very attractive, flesh white, tender, very good, productive but not always an annual cropper, seems to do very well in Maryland and is a good one to follow Yellow Transparent and Early Ripe.

Rhode Island (Greening)—Another old standard northern winter variety which does well in Western Maryland.

Rome (Beauty)—Medium to very large, one-half or more covered with bright red or red striped, attractive, roundish conic, bears early, very productive but fruits vary much in size many becoming too large, likely to drop badly if not picked at proper time, good, early winter. Properly handled this is a good variety for Maryland and will probably succeed well in the mountains.

Roxbury (Russet)—Above medium size, oblate somewhat conic but irregular; greenish more or less covered with yellowish-brown russet sometimes with bronze blush; good to very good quality, winter.

Shockley—Small conic, red striped or nearly red, fair quality, winter, not recommended.

Smith Cider—Medium to large, roundish to conic or oblong, mottled or striped with rich red and attractive when well grown, fair quality, early winter.

Smokehouse—Medium to large, roundish oblate, yellowish green marked with russet, partly covered or striped with dull red, good, usually productive, winter.

Stark—Medium to very large, roundish slightly conic, dull green or yellowish with little or much dull red blush, productive, biennial bearer, good quality, winter. Much subject to bitter rot and needs three or four extra sprayings.

Stayman Winesap—Medium to very large, oblate-conic to oblong-conic, often dull red but sometimes red splashed and mottled toward blossom end only. Flesh crisp, juicy, excellent, winter. Trees from the nursery come into bearing young and are productive of even sized fruit, but topworked trees are likely to produce fruit uneven in size for the first few years. This will undoubtedly be the leading winter variety in most sections of Maryland.

Summer Rambo—Large, oblate, green with red striping or solid red cheek, excellent for dessert and market, productive, early fall, tree vigorous and healthy, worth planting.

Tompkins King—Large, oblate-conic, nearly covered with bright rich red, excellent, winter, fairly good cropper, tree not very hardy, should be topworked on Red Astrachan or Northern Spy, good for Western Maryland.

Vandivere—Probably Newtown Spitzenburg—Medium, roundish cylindrical, striped with carmine and blushed with dull red, winter.

Twenty Ounce—Very large, rich yellow mottled or striped with bright rich red, roundish or roundish long conic, excellent, late fall, rather good cropper, tree trunk is weak and it should be topworked on Red Astrachan or Northern Spy, good for Western Maryland.

Wagener—Medium or above, oblate to somewhat roundish, often irregular, partly covered with pinkish red and carmine, excellent for dessert and market, early winter, tree rather weak but a fairly good cropper, should be topworked on a strong growing variety.

Walbridge—Medium or above, roundish conic, washed with red and striped with carmine, fair to good, early winter, not recommended.

Wealthy—Above medium, roundish-conic, smooth in outline, very attractive, rich red either in solid color or in splashes, good to very good, late fall or early winter, productive with good care, tree very hardy, grown principally in the western part of the State but ought to do well elsewhere.

Wine—Large, globular, red striped or nearly red, good, hardy and productive, winter.

Winesap—An old variety which does especially well in Maryland. Fruit medium or above, usually conic, very attractive rich but dark red, sometimes partly mottled with rich red, very good, winter, productive annual bearer with care, tree hardy with slender weeping twigs, does best on light soils, good for the entire State.

Winter Banana—Medium to large, oblate conic to roundish conic, often irregular, very attractive, rich light yellow with pink blush, good, early winter or late fall, productive. Worth trying throughout the State if a yellow apple of this season is desired.

Winter Paradise—Medium or above, roundish oblate, dull greenish yellow often with blush, sweet, winter.

Wolf River—Very large, flat at base, conic or roundish conic, very attractive, pale yellow blushed or splashed with bright red, tree very hardy and usually a good cropper, fair quality, early winter. Where such a large apple is desired this variety is usually profitable.

Yellow Bellflower—The old standard tart cooking apple but a rather shy bearer, succeeds in Western Maryland.

Yellow Newtown—Medium to large, roundish oblate, angular, often oblique, bright yellow sometimes with pink blush and clouded white at base, very best quality, late winter. This variety has not been grown enough in Maryland to determine its adaptability but where it succeeds it ought to be immensely valuable. It should be given a thorough trial in at least the northern tier of counties.

Yellow Transparent—Small to medium or above, conic, white when ripe, good, very productive. This is the first of the summer varieties to ripen and is picked in June in Southern Maryland and in the southern part of the Eastern Shore. It is a hardy Russian variety, succeeds over the entire State and is very profitable. It is quite susceptible to fire blight but seems to overcome this injury.

York (*Imperial*)—Medium to large, oblate to oblong usually oblique or lop sided, bright heavy red, very firm flesh, fair quality, heavy cropper, late winter. This variety succeeds well and is profitable but good fruit growers ought to plant varieties of better quality which will be even more profitable like Stayman Winesap and Jonathan.

COST OF STARTING AND MAINTAINING AN ORCHARD.

Most fruit growers do not keep records of the expense entailed year after year in caring for their orchards so it is impossible to state the approximate expense and profit of an orchard in most parts of the State. A set of questions was sent to several successful fruit growers in order to throw light on the expense of starting and maintaining an orchard, the crops grown while the trees were young, the age of first bearing, the age of first profit, the average value of crop and the value of heaviest crop.

The following detailed statement by Mr. E. P. Cohill, Hancock, of his eleven year old thirty acre orchard is most valuable as a guide for Western Maryland. This orchard was handled as follows:

First year—Narrow strips cultivated along tree rows and cowpeas grown in middles.

Second year—Same as first year except that crimson clover was grown instead of cowpeas.

Third year—Same as second year.

Fourth year—All of the ground cultivated until August when red clover seed was sown.

Fifth and sixth years—Strips cultivated along tree rows and red clover left on middles until August when all of the ground was plowed and seeded to red clover.

Eleventh year—All of the ground cultivated until August 15 when red clover seed was sown. Two hundred pounds per acre of a mixture of 12 per cent phosphoric acid and 5 per cent potash, were applied August 15.

Eighth year—Not cultivated.

Ninth year—Cultivated with disc two or three times.

Tenth year—Cultivated with disc twice.

Eleventh year—Cultivated with plow and disc four or five times and mowed two times.

Hogs were pastured in the orchard from May 1 to November 1 during the first six years. Mr. Cohill states that the manure and clover plowed under in this orchard have increased the value of the land at least twenty dollars per acre. This orchard is kept in clover every **winter.**

There are 3000 trees set 20 feet apart each way in the 30 acres. They were planted in November, 1902 and April, 1903. Labor is figured at 15 cents per hour.

Statement by Mr. E. P. Cohill, Hancock.

3000 trees	at 12c.		$ 360.00
Plowing before planting			72.00
1st year, 1903.			
Fertilizer and Tobacco Dust			25.00
Planting			63.00
Manure			75.00
Cultivating			215.00
Cowpeas and Clover seed			78.00
By Hog pasture		84.00	
Total	$	84.00	$ 888.00
2nd year, 1904.			
Cultivating			178.00
Manure			67.00
Pruning			12.00
By Hog pasture		96.00	
Total	$	180.00	$ 1,145.00
3d year, 1905.			
Cultivating			225.00
Manure			120.00
Pruning			26.00
By Hog pasture		100.00	
Total	$	280.00	$ 1,516.00
4th year, 1906.			
Cultivating			318.00
Manure			125.00
Pruning			12.00
Clover seed			17.00
By Hog pasture		171.00	
Total carried forward		451.00	$ 1,988.00

Total brought forward	$ 451.00	$ 1,988.00
5th year, 1907.		
Cultivating		260.00
Manure		135.00
Pruning		22.00
Spraying		86.00
By Hog pasture	150.00	
By Apples and Cider	65.00	
Total	$ 666.00	$ 2,491.00
6th year, 1908.		
Cultivating		367.00
Manure		60.00
Pruning		20.00
Spraying and material		225.00
By Hog pasture	141.00	
By 150 bbls. Apples and Cider	308.00	
Clover seed		24.00
Picking, packing and handling apples		63.00
Total	$ 1,115.00	$ 3.250.00
7th year, 1909.		
Cultivating		165.00
Manure		115.00
Pruning		17.00
Spraying and material		293.00
Fertilizers		78.00
Picking, packing and handling		255.00
By Hog pasture	192.00	
By 850 bbls. Apples and Cider	1,952.00	
Total	$ 3,259.00	$ 4.173.00
8th year, 1910.		
Gasoline Spraying Outfit		250.00
Manure		55.00
Pruning		72.00
Spraying for Scale		75.00
Lime Sulphur		175.00
Spraying for Codling Moth, Labor and Material		111.00
Picking, Packing and Putting Apples on Cars		806.93
Barrels		1,454.25
By 4155 Barrels of Apples and Cider	6,736.95	
Total carried forward	$ 9,995.95	$ 7,172.18

Total brought forward	$ 9,995.95	$ 7,172.18
9th year, 1911.		
Manure and Clover Seed		150.00
Pruning		85.00
Spraying for Scale		144.80
Lime Sulphur		200.00
Fertilizer		52.00
Spraying for Codling Moth, Labor and Material		126.00
Packing Shed		125.00
Cultivating		96.00
Picking, Packing and Putting Apples on Cars		605.59
Barrels		648.90
By 1854 Barrels of Apples and Cider	4,105.30	
Total	$14,101.25	$ 9,405.47
10th year, 1912.		
Pruning		100.00
Spraying for Scale, Labor and Material		296.00
Spraying for Codling Moth, Labor and Material		147.76
Cultivating		44.00
Lime		115.00
Phosphate		42.00
Clover Seed		45.00
Summer Spraying and Material		351.17
Picking, Packing and Putting Apples on Cars		1,355.89
Barrels		1,745.45
By 4987 Barrels of Apples	8,258.12	
Cider on Hand—Not Sold	150.00	
Total	$22,509.37	$12,647.74
11th year, 1913.		
Cultivating		125.68
Pruning		90.00
Spraying for Scale, Labor and Material		255.74
Spraying for Codling Moth, Labor and Material		206.76
Mowing—Two Times		52.00
Picking, Packing and Putting Apples on Cars		318.46
Barrels		240.00
By 679 Barrels Apples and Cider Apples	1,701.35	
Total for Eleven Years	$24,210.73	$14,936.60

These figures show that up to the end of the seventh year the orchard had not been self-supporting by $914.00, yet if we consider the increased value of the land, due to manure and cover crops, at $20.00 per acre the deficit is reduced to $314.00.

At the end of the eleventh year the statement shows a profit of $9,274.13 or an average of $309.13 per acre, a net profit of nearly thirty dollars per acre per year. The crop in 1913 was very light, but was given extra attention. The orchard will not be cultivated the following year.

Another orchardist in Washington County makes the following statement from memory as he has not kept accurate records:

The trees cost $4.80 per acre and the planting $1.00 per acre. Crops were grown among the trees for the first five years and about paid the running expenses of the orchard. Ben Davis began to bear at eight years and York at twelve years of age. At the present time one half of the orchard is twenty-one years old and the other half eighteen years and the most profitable crop brought $150.00 per acre while the average income is about $90.00 per acre. The crop is good on bearing years and about one-fourth of a crop on off years. Spraying costs $15.00 per acre, pruning $1.50, picking, etc., $16.00 annually.

TREATMENT FOR APPLE IN FOLIAGE.

In addition to the dormant spray for scale, apple trees should be sprayed before the blossoms open, or just as they begin to show pink, with concentrated lime-sulfur, diluted at the rate of one gallon of the manufactured product to 40 gallons of water. This spraying is applied to prevent early scab infection. Early infection from this fungus may often cause a dropping of the young forming fruits resulting in a light crop, and be responsible for leaf injury later on. As scab is not often serious here, in the vast majority of cases this spraying is omitted by Maryland growers, their dependence being placed in the next spraying.

The second treatment should be applied just as the blossoms are falling, using the concentrated lime-sulfur 1-40 to which is added 2 pounds arsenate of lead. This combined spray serves to further check the development of scab and injury from the codling moth. This treatment should be very thorough, as it is usually the most important of all.

A third spray with a like solution about two weeks after the second is advisable though not always necessary. More particularly is it necessary to prevent attack from disease than late appearing codling moths.

A fourth treatment, about eight weeks after the blossoms fall, or about the first of July, is quite necessary, not only to prevent injury from the second brood of codling moths, but attacks of bitter rot and other diseases. In all these sprayings the same combined concentrated lime-sulphur 1-40 and 2 pounds arsenate of lead can be used, or for the later spraying bordeaux is usually profitable, as lime-sulfur is not a sufficiently strong fungicide for such diseases as bitter rot. For the earlier sprayings bordeaux is apt to russet the fruit especially in certain varieties such as Grimes and Ben Davis. In making bordeaux, use the 4-5-50 formula, viz., 4 pounds copper sulphate, 5 pounds lime to 50 gallons of water, 2 pounds arsenate of lead being added to form a combined spray.

Apple Insects and Diseases.

The following brief notes on insects and diseases are mostly taken from bulletins of this Experiment Station and have been approved by Prof. T. B. Symons, Entomologist, and Prof. J. B. S. Norton, Pathologist. A complete spray calendar and discussions of bordeaux mixture appear in Bulletin No. 142.

Codling Moth—Causes wormy apples; for complete account of this insect see Bulletin No. 142.

Remedy—Spray with arsenate of lead or Paris green as soon as petals fall from the blossoms; repeat in one week and again ten days or two weeks after the second spraying. Add the poison to bordeaux and thus spray for insects and diseases at the same time. Use two pounds of arsenate of lead or five ounces of Paris green to fifty gallons of bordeaux.

San Jose Scale—This is too destructive an insect to discuss briefly, complete directions are given in Bulletin No. 140.

Plum Curculio and Apple Curculio—Cause apples to become knotty and misshapen.

Remedy—If the spraying for codling moth does not control the curculios then the trees will need to be jarred early in the morning and the insects caught on canvas spread beneath the trees.

Tent Caterpillar—Forms web nests in the trees in spring or fall and eats the foliage.

Remedy—Tear out the nests and destroy the caterpillars if the poison spraying for codling moth does not control them.

Apple Aphides—These live over winter in the egg stage on the trees.

Remedy—Fifteen per cent kerosene emulsion as soon as the eggs hatch in spring or "Rose leaf" tobacco extract one part to 40 or 50 of water.

Woolly Aphis—Lives on roots and tops.

Remedy—Same as for other aphides on the limbs. To kill those on the roots remove three or four inches of soil for a distance of three or four feet around the tree and sprinkle on six or eight pounds of tobacco dust, throw back the earth at once.

Oyster Shell Scale—These resemble miniature oyster shells on the limbs.

Scurfy Scale—This looks like little white flakes on the trunk and limbs.

Remedy—The spraying for San Jose scale and aphides will control these scales.

BORERS—Dig out the borers with a knife or copper wire in May.

BARK BEETLE OR SHOT HOLE BORER—Small black beetle, bores minute holes in limbs and trunks.

Remedy—Cut out and burn infested parts, keep all rubbish cleaned up.

APPLE SCAB—Kills portions of leaf tissue and leaves turn yellow. Also kills little fruit stems in spring and causes black diseased spots on fruit.

Remedy—Spray with bordeaux before the buds open and again as soon as the petals fall. Ten days later spray again.

RUST—Causes thickened yellow spots on the under side of the leaves. One stage of the disease causes "cedar apples" on cedar tree and it is worse on some varieties when cedar trees are near the orchard.

Remedy—Cut out the cedar trees, spraying is not very effective.

FIRE BLIGHT—The leaves turn brown and die. It also kills blossoms and fruit spurs causes canker spots in the bark.

Remedy—Cut out and burn the diseased twigs, cut away the cankered bark and paint the wounds with white lead and linseed oil.

CANKER, BODY BLIGHT, COLLAR ROT—Pare away diseased bark and paint with white lead and linseed oil.

FRUIT SPOT—Causes small dark colored spots beneath the skin.

Remedy—Same as for bitter rot.

BITTER ROT—Appears on the fruit as brown decayed spots with concentric rings.

Remedy—About June 15 use bordeaux and make four or five more applications at intervals of two weeks. Other fruit diseases such as sooty blotch, fly speck disease, fruit blotch, etc., will be controlled by the treatment necessary for scab and bitter rot.

BLACK ROT—Causes darker spots than bitter rot does. As rot increases, scattered black dots appear and decayed part turns black and dries up.

Remedy—Same as for apple scab.

CROWN GALL—Appears as knotty swellings on the crown or union of root and top and on the roots. Root grafted trees seem to develop it badly in the nursery. Very often thick tufts of fibrous roots known as "hairy root" are associated with it.

Remedy—Do not plant trees that show any indication of galls or thick tufts of roots.

THE MARYLAND AGRICULTURAL EXPERIMENT STATION.

BULLETIN 179. MARCH, 1914.

THE QUALITY OF CLOVER AND VETCH SEED FOUND IN MARYLAND MARKETS.

In 1913.

By C. P. Smith.

Introduction.

Soon after the passage of the Maryland seed bill of 1912, the State Board of Agriculture appointed the writer Seed Inspector and Analyst. In order to reduce expenses to the minimum and make the appropriation provided by the law go as far as possible, the office and laboratory was established in a room furnished by the State Agricultural Experiment Station, many of the facilities of that institution being thus made available without cost to the seed work.

The equipment of the laboratory is being gradually augmented; but the principle need of the laboratory at present is the time of additional assistants, for whose salaries the money is not available. For the same reason the one in charge of the work must give much of his time to teaching in the college, whereas undivided attention to the seed work would have meant much more work done and more prompt and frequent reports of the results obtained in the laboratory, etc.

Unofficial Samples.

All samples sent to the laboratory for attention were given careful consideration and reported out as promptly as possible. Most of these, some 100 in number, were sent by dealers, and not one was submitted by a buyer in full conformity with Section 51-C of the law. In certain cases our reports were furnished with the understanding that same should not be used in any legal proceedings.

We will continue to accommodate, free of charge, any resident of Maryland with reports upon samples submitted; but the time may come when we will find it necessary to make a small charge, or limit the number of samples per specified time, in the case of dealers.

Official Samples.

No sample sent in by any person or persons is classified in our official series, as only those samples that are collected by the inspector, or his deputies, is regarded as official and the results of the analysis published. Much care has been exercised in the taking of all samples in order that each sample be as representative as possible of the contents of the bag or bags from which it was drawn, it being our constant effort to avoid, in our sampling, conditions that might eventually reflect unjustly upon the innocent vendor. Some 720 official samples were thus collected in 1913, every one of them by the inspector, personally.

Labeling.

The wording of Section 51-B of the seed law has allowed some looseness of interpretation as to the label requirements. Only one Maryland wholesale house began labeling all shipments within the State upon the law taking effect October 1, 1912; but others soon began the practice at the advice of the inspector. In the case of the numerous retail dealers visited, very few indeed had their goods labeled, except where the tags of Baltimore merchants had not been removed. In many instances, however, tags giving the analyses had been torn off and destroyed, as many of the vendors do not care to have their customers know from whom their stocks are obtained, etc. The goods therefore were exposed for sale and sold unlabeled, the vendor sometimes claiming ignorance of the law, often, however, admitting indifference to be responsible for his negligence. Practically all stocks purchased outside of the State were shipped in unlabeled as to purity, etc. The inspector has constantly advised the vendors in such cases to insist on having proper analyses supplied with the goods and to put on their own tags or placards the analyses furnished, in case they do not want the name of the firm or firms whose goods they handle to be known to their customers or competitors. A few have followed this advice, while some have had their goods unlabeled even after a second and third visit of the inspector. Where the local dealer has purchased local grown seed from nearby farmers, only one case has been noticed by us where such seed has been analyzed or labeled in any way before being re-sold. Commonly, in addition, such seed has not been cleaned, and the high percentage of foreign seeds contained would not make a good appearance on a label in comparison with labels of well-cleaned grades put out by the regular merchants. The vendor accordingly feels that he should not be required to have such goods analyzed and labeled, and such probably will not often be done until a more rigid inspection is made possible and penalties provided for non-conformity with the law.

DIFFERENCES IN ANALYSES AND THEIR INTERPRETATION.

Unfortunately, the analysis of seeds is not as definite and constant a proposition as is the analysis of fertilizers, chemicals, etc. Variations in results, as expressed in figures of percentage, will occur in different samples taken from the same bag, same part of a bag, and even different portions of one well-mixed sample. The lower the purity of the stock, the more variation should be expected and usually will be obtained. Some guide to help interpret these variations is therefore needed, and this laboratory has started a series of experimental and comparative analyses from which we hope to be able to deduce a reliable schedule for use in this connection. On the basis of some preliminary co-operative tests already conducted, we temporarily offer the following figures to indicate what now seems to us ought to be reasonable variation in purity given and found.

Purity.	Variation Allowed.
99.50—100.00%	0.15%
99.00— 99.50	0.25
98.00— 99.00	0.50
95.00— 98.00	0.75
90.00— 95.00	1.00

By this we mean that if the purity is given as 96.00% and our test yields a figure anywhere from 95.25 to 96.75, it should not necessarily be concluded by the reader that the dealer or dealers in the case are guilty of intentional misbranding of goods. Unfortunately, however, unscrupulous dealers will probably be able to take unwarranted advantage of such an allowance for variation and the figures given above will probably be found to be too liberal.

OTHER INTERPRETATIONS OF ANALYSES.

Attention should be called now to our reasons for claiming that the percentages of both inert matter and foreign seed should certainly be given on the label with the percentage of purity. The following analyses of red clover samples will illustrate:

		Purity.	Inert Matter.	Foreign Seed.
	a)	95.40	3.40	1.20
	b)	96.90	1.10	2.00
and				
	c)	98.24	0.60	1.16
	d)	98.86	0.74	0.40

Altho "b" shows a higher purity than "a" by 1½%, and "d" exceeds "c" in the same way by over 0.50%, we would rather purchase and plant the first than the second, and the fourth and than the third, because of the lower percentage of foreign seed in the ones selected, the kinds of foreign seeds being unknown and assumed to be noxious in both cases, as that is the only wise thing to do. On the contrary, if the label told us what kinds of seeds made up the foreign seed percentage, we might have reversed the above decision. Two of our alsike samples will explain:

e)	98.40	0.40	1.20
f)	95.54	0.96	3.50

Here a study of the foreign seed constituents shows that in "e" the 1.20% represents 6750 weed seeds per pound, most of which are sheep sorrel, while in "f" only 600 weed seeds per pound are sown, 450 yellow trefoil and no sheep sorrel. 34.8% of the total foreign seed, in the first case, and 97.6%, in the second case, are white clover, red clover, and timothy and these are commonly not considered objectionable in alsike clover. In fact the day will probably come when our law will call for four percentages, instead of three, substituting "noxious weed seeds" and "other foreign seeds" for the now insufficient "foreign seed" percentage. The injustice, in this instance, works against the dealer as much as the buyer, and we have noticed labels that gave the percentages of white clover and timothy, where the total foreign seed percentage was high because of the abundance of those seeds in the stock.

Explanation of Tables.

The following tables include our report on the purity tests of the official samples of red clover, crimson clover, white clover, alsike, alfalfa, the sweet clovers, and hairy vetch. The official sample of timothy, millets, orchard grass, and other grasses are not yet ready for publication; but the work is being pushed and will be reported as soon as possible.

Each variety of seed is discussed and treated separately, in the tables the samples being first classified according to the place collected, the towns arranged alphabetically, as also the dealers under each town or post office. First comes the number under which the sample is filed in the laboratory; this is followed by the name of the vendor or local dealer, below which is added the name of the wholesale dealer or merchant, when known—(unless the sample is secured direct from the wholesaler's warehouse); next is recorded the analysis, above as given by the dealer (G), below as found by our laboratory (F); and further may be given some figures showing the approximate number of certain foreign seeds per pound of sample, or the relation in percentage of certain foreign seeds to the total foreign seed content.

RED CLOVER.

(Trifolium pratense.)

We are here drawing no distinction between mammoth, sapling, large, small, or medium red clover,—all of which are known as "English Clover" in certain parts of the State.

An unusually large crop of red clover seed was harvested in several Maryland counties in 1912. Some of this found its way to the cleaning mills of the larger wholesale dealers and returned to the farms a respectable product; but many local dealers bought and sold many bushels of this clover seed, uncleaned, unlabeled, and teeming with ripple, green foxtail, and plantain seeds. When a farmer returns to his soil as much as 84,420 foreign seeds with each pound of seeds planted (844,200 per acre, at 10 pounds), we wonder why he plants the clover at all. Also many farmers bought from their neighbors this uncleaned, unlabeled seed. On the other hand, a few cases were noted where the farmer had cleaned his product so well that we could hardly believe we were not misinformed as to the source of the stock in question. Of a few samples, secured direct from farmers, of stocks not for sale, we may here contrast the extremes:

	Purity.	Inert Matter.	Foreign Seed.
a)	98.94	0.78	0.28
b)	59.56	10.30	30.14

"b" having 29.28% ripple (also called buckhorn, rib-grass, and English plantain),—131,850 to the pound, 8,233 to the sq. rod. Are you unconcerned as to which you may plant?

We were pleased to note the infrequency of dodder seed this year.

CRIMSON CLOVER.

(Trifolium incarnatum.)

This clover is also called Scarlet Clover and is well known as a most valuable nitrogen-plant to precede corn. Its value is duly appreciated by Maryland planters and many bushels of the seed were sold in the State in 1913. While some home-grown seed was produced and used, the great bulk of the seed on the market was imported seed. This was French grown and was of good quality.

The very constant presence of yellow trefoil as a foreign seed was a surprise, 92 of the 110 samples containing same. To the tables is accordingly added the relation of the yellow trefoil seed to the total foreign seed, in terms of the approximate number of seeds per pound. While the yellow trefoil plant is not objectional as a pasture or roadside weed, being often eaten by stock, it is of much less value than the crimson clover and if too common in the corn field must be branded as an unwelcome guest. The seed is smaller and flatter than the crimson clover, but is of about the same color and will easily be passed unnoticed, unless in the "hull" or pod, which is nearly black, wrinkled, and conspicuous. Its presence in the 1913 imported seed of crimson clover is evidently not a case of adulteration, but a case of the tolerance of the plant as a weed in the seed-growing fields, the grower, not the seed merchant, being primarily responsible.

One sample, said to be English grown, yielded cut-leaved cranesbill as the only foreign seed. As the per cent. by weight was only nine-hundredths of 1% (0.09), the foreign seed content of this lot should cause no worry on the part of either dealer or planter. Five samples, said to be Maryland grown, have field-peppergrass as the most plentiful foreign seed, as might be expected from the prevalence of that weed in our cultivated fields. Another sample, said to be Delaware grown, shows an occasional yellow trefoil seed, but no field-peppergrass.

The seed-coat of the crimson clover is much thinner and the whole seed more brittle than in our other familiar clovers, so that much breaking of seed may occur with the rough handling of the bags in shipping, thus adding to the inert matter and reducing the percentage of purity. This should be considered by the buyer upon checking up with the analysis of the shipper, as well as by our readers in comparing our analyses with those furnished by the dealers.

WHITE CLOVER AND ALSIKE.
(Trifolium repens and T. hybridum.)

These two clovers may be considered together here, the foreign seed percentage of each being usually generously swollen by the presence of seed of the other. Sheep sorrel and yellow trefoil predominated as noxious weed seeds and we have contrasted the sum of alsike and timothy (or white clover and timothy) with the two weeds mentioned, in terms of the total foreign seed content as 100%. Only rarely did any other weed appear in any abundance, and three such cases are noted in footnotes.

ALFALFA.
(Medicago sativa.)

Alfalfa has proved to be one of the most desirable hay or fodder crops known in America. Maryland should be growing many more tons of alfalfa hay, and undoubtedly would be doing so but for the difficulty many have experienced in getting a field started. While preparation of the soil and other factors may have been largely responsible for many failures, sufficient evidence is at hand to show that selection of the seed to start with is of fundamental importance, and that certain commercial varieties do not do well with us on the Atlantic Sea Board. Arabian alfalfa cannot be depended upon for more than one-fourth of a crop, but we have yet to find this type on sale in Maryland and the price is ordinarily high. Seed said to have been grown in Southern Italy has given unsatisfactory results, while the seed known commercially as Turkestan alfalfa only occasionally gives satisfaction, and many failures in alfalfa growing in Maryland must be laid to the use of this seed. Comparison of numerous plantings of this variety, along side of plots sown with American and European grown seed, has shown that the crop yield, as well as the life of the stand, is much less in the case of the Turkestan product. Typical Turkestan seed has a covering of very finely divided clay over each seed, giving the bulk a decided grayish hue; but recleaning and polishing of this seed is now being practiced, leaving the bulk almost the same color as the European seed, a bright yellow-brown. However, a certain whitish weed seed, about the size and shape of the seeds of our common thistles, will, when present, identify the polished Turkestan seed. American grown seed, at least when new, has a greenish-yellow hue.

The alfalfa fields of certain of our western states yielded an abundant crop of seed during 1913, so that American grown seed is available in unusual quantity for 1914, and at a price within the reach of all. Consequently, in November last, we issued a circular to Maryland seed dealers, calling attention to this subject and we hope that all alfalfa planters in 1914 will call for and be able to get American grown seed.

At least 34 out of our 46 samples are Turkestan seed. Yellow trefoil was evidently not used as an adulterant, as in certain former years, tho 9 of our samples contained a few seeds of this weed. The roquette, a European mustard recently introduced into North America with alfalfa seed, and especially abundant in New York alfalfa fields in 1911, causing considerable concern, appeared in only three of our samples and there in insignificant quantity. In general, the foreign seed content of the samples secured was of relatively limited importance, red clover constituting more than 50% of the total foreign seed in the two cases where the foreign seed percentage exceeded 1% of the whole.

Sweet Clovers.

The sweet clovers are native of the old world, three kinds having been long since introduced into this country. These are: the "Bokhara" or white sweet clover, Melilotus alba; the biennial yellow sweet clover, Melilotus officinalis; and the annual yellow-flowered species, Melilotus indica. Of these three species, two have been represented in the seed stocks exposed for sale in Maryland in 1913. Four samples were taken and tested as follows:

WHITE SWEET CLOVER.

			Purity	Inert Matter	Foreign Seed
	BALTIMORE				
130704	Wm. G. Scarlett & Co..............	G	....	....	....
		F	97.24	2.16	0.60
	POCOMOKE CITY				
130534	Peninsula Produce Exchange......	G	....	....	....
		F	97.05	2.90	0.05

ANNUAL YELLOW SWEET CLOVER.

	BALTIMORE				
130593	J. Bolgiano & Son..................	G	....	....	....
		F	99.16	0.52	0.32
	HAGERSTOWN				
130629	E. W. Miller........................	G	....	....	....
		F	97.05	2.90	0.05

130534 was labeled "Bokhara or Yellow Sweet Clover," 130593 was labeled "yellow-flowered sweet clover," and the last was labeled simply "sweet clover."

The growing of sweet clover in Ohio, Kansas, etc., has been considerably advocated in recent years. As a hay and pasture crop, and as a soil improver, it is said to be of great value. Our opinion is, however, that for average Maryland conditions, that where sweet clover will thrive, alfalfa will also do as well and we had better put our time and money into securing the right kind of alfalfa stands. The practice of planting some sweet clover with alfalfa seed, "to inoculate the soil," has no virtue as far as we have yet been able to establish. As bee-plants, however, both of the biennial sweet clovers are of undisputed value.

HAIRY VETCH.
(Vicia villosa.)

Only 13 samples of the seed of this important cover-crop plant were obtained by us in 1913. North of us, this plant is better known as "winter vetch." Special attention was given to these samples because of the recent findings of the federal seed laboratory in connection with the foreign seed elements of stocks. Only four of our samples showed a heavy foreign seed percentage, and none of these can justly be said to have been misrepresented by the analysis furnished. The foreign seeds found were mostly other vetches, not noxious in character on their own account, but of considerably less value than the hairy vetch, both in price and as cover-crop plants. The three more important vetches present were: spring or bird vetch, Vicia sativa; mottled-seeded narrow-leaved or common vetch, Vicia angustifolia; and black-seeded narrow-leaved vetch, Vicia angustifolio, variety (?). For conveniense these names are contracted to spring vetch, mottled vetch, and black vetch, respectively, in the tables, where the approximate number of each per pound is given. The corn cockle, however, must be considered a noxious weed and its presence in 9 out of 13 samples is noted. At 60 pounds per acre, one might have sown some 24,000 of these seeds to the acre, in using stock represented by one sample. No other foreign seeds appeared in sufficient quantity to warrant comment.

RED CLOVER.

Lab. No.	Source of Sample. Vendor and Merchant.	Analysis. Per Cent. By Weight.				Some Foreign Seeds. Approximate No. per Lb.			
		Given.... Found....	Pure Seed....	Inert Matter..	Foreign Seed....	Total Foreign.	Ripple....	Plantain..	Green Foxtail..
	ANNAPOLIS.								
130308	H. B. Myers Co................	G	97.00	......	....				
	W. A. Simpson & Co	F	94.74	3.40	1.86	8190	3780	720	1080
130311	H. B. Myers Co.................	G	97.50	......	....				
	W. A. Simpson & Co.........	F	96.48	2.12	1.40	5490	810	180	2430
	BALTIMORE.								
130152	J. Bolgiano & Co...............	G	97.04	1.13	1.83				
		F	97.86	1.70	0.44	1800	1530	0	0
130133	" "	G	97.05	1.33	1.62				
		F	96.28	1.56	2.16	9720	4770	2160	1080
130134	" "	G	95.36	1.45	3.19				
		F	95.40	3.40	1.20	4400	2700	180	900
130357	" "	G	97.34	1.11	1.55				
		F	95.56	2.42	2.02	9270	3870	720	3240
130671	" "	G	.....	....	....				
		F	99.37	0.58	0.05	360	0	0	0
130193	J. J. Buffington & Co..........	G	98.71	0.65	0.64				
		F	98.68	0.96	0.36	540	180	0	0
130194	" "	G	99.36	0.32	0.32				
		F	99.00	0.30	0.70	2880	1260	270	810
130204	" "	G	97.43	1.45	1.12				
		F	97.64	1.46	0.90	2790	1530	270	90
130214	" "	G	99.37	0.47	0.16				
		F	98.86	0.74	0.40	1350	0	0	90
13091	Griffith & Turner Co...........	G	98.00	....	....				
		F	98.24	0.60	1.16	3600	450	90	1440
130101	" "	G	Uncleaned.						
		F	94.90	1.10	4.00	17640	15410	90	0
130102	" "	G	Uncleaned						
		F	96.90	1.10	2.00	11340	1980	1080	3780
130159	Wm. G. Scarlett & Co.........	G	98.50	0.60	0.90				
		F	97.76	1.00	1.24	6930	90	630	2160
130160	" "	G	99.70	0.10	0.20				
		F	99.20	0.50	0.30	1170	0	0	810
130161	" "	G	98.90	0.50	0.60				
		F	97.98	0.92	1.10	5130	0	0	1620
130162	" "	G	98.50	0.90	0.60				
		F	98.76	0.88	0.36	2160	0	0	0
130163	" "	G	98.10	0.70	1.20				
		F	97.30	0.90	1.80	9540	0	180	1980
130363	" "	G	99.60	0.20	0.20				
		F	98.98	0.80	0.22	1260	0	450	270
130364	"	G	98.20	0.50	1.30				
		F	96.24	2.16	1.60	9900	180	1170	7740
130674	'	G	99.20	0.40	0.40				
		F	99.51	0.26	0.23	810	0	0	0

RED CLOVER—CONTINUED.

Lab. No.	Source of Sample. Vendor and Merchant.	Analysis. Per Cent. By Weight.				Some Foreign Seeds. Approximate No. per Lb.			
		Given... Found...	Pure Seed...	Inert Matter...	Foreign Seed...	Total Foreign.	Ripple ...	Plantain..	Green Foxtail.
	Baltimore—Continued.								
130675	Wm. G. Scarlett & Co.	G	99.60	0.30	0.10				
		F	99.61	0.36	0.03	180	0	0	0
130683	" "	G	99.40	0.40	0.20				
		F	98.99	0.86	0.15	1080	0	630	0
130685	" "	G	99.60	0.30	0.10				
		F	98.84	0.96	0.20	1080	0	90	0
130149	W. A. Simpson & Co.	G	98.53	0.48	0.99				
		F	98.20	0.70	1.10	3150	0	270	1800
130150	" "	G	98.65	0.42	0.93				
		F	98.80	0.80	0.40	810	360	0	0
130572	" "	G	.....	....	....				
		F	97.64	1.76	0.60	5310	0	0	0
130665	" "	G	99.00	....	....				
		F	99.43	0.38	0.19	1170	0	0	0
130666	" "	G	98.50	....	....				
		F	99.31	0.64	0.05	900	0	450	0
130720	" "	G	99.21	0.20	0.59				
		F	99.16	0.32	0.52	3690	90	180	90
130721	" "	G	99.37	0.10	0.53				
		F	99.46	0.34	0.20	1170	0	90	180
130191	Wiseman & Downs	G	Unlabeled.						
		F	91.40	2.01	6.59	41040	37620	0	0
130192	" "	G	.....	....	....				
		F	93.90	1.24	4.86	27900	23310	0	0
	BERLIN.								
130509	Berlin Hardware Co.	G	.....	....	....				
		F	98.18	1.34	0.48	2520	0	810	360
	BETTERTON.								
130219	Turner & Son	G	97.42	1.29	1.29				
	J, J. Buffington & Co	F	97.14	1.20	1.66	7110	2880	540	1800
	CAMBRIDGE.								
130292	Oliver Spedden	G	96.45	1.78	1.77				
	J. J. Buffington & Co.	F	96.06	2.06	1.88	6300	3420	0	990
130305	Cambridge Seed & Grocery Co.	G	Unlabeled.						
	Wm. G. Scarlett & Co.	F	96.34	2.46	1.20	5670	900	270	1980
130306	Cambridge Seed & Grocery Co.	G	Unlabeled.						
	Wm. G. Scarlett & Co.	F	96.02	2.64	1.34	8640	360	540	1440
130307	Cambridge Seed & Grocery Co.	G	99.00	....	....				
	W. A. Simpson & Co.	F	97.24	1.72	1.04	5040	630	720	2880
130300	B. C. & A. wharf	G	97.78	0.99	1.33				
	J. Bolgiano & Son	F	95.66	3.28	1.06	3690	2070	0	90
130302	B. C. & A. wharf	G	95.00	3.00	2.00				
	Griffith & Turner	F	93.54	3.66	2.80	14310	6120	5580	1890

RED CLOVER—CONTINUED.

Lab. No.	Source of Sample. Vendor and Merchant.	Analysis. Per Cent. By Weight.				Some Foreign Seeds. Approximate No. per Lb.			
		Given .... Found	Pure Seed..	Inert Matter..	Foreign Seed....	Total Foreign.	Ripple..	Plantain..	Green Foxtail..
	CENTERVILLE.								
130248	P. T. Foreman & Bro...........	G	97.00	.....	....				
	W. A. Simpson & Co.........	F	95.54	1.96	2.50	12600	3240	810	1170
130251	G. D. Neavitt.....................	G	91⅝	2⅞	5½				
	J. J. Buffington & Co.........	F	88.84	5.00	6.16	28080	19890	1350	5400
130254	G. D. Neavitt.....................	G	91¾	2¾	5½				
	J. J. Buffington & Co.........	F	92.70	1.65	4.00	16830	9270	4320	3330
130249	Wright & Lowe...........	G	99.00	....	....				
	W. A. Simpson & Co..........	F	98.86	0.64	0.50	2700	0	360	180
130250	Wright & Lowe.......	G	97.00	....	....				
	W. A. Simpson & Co..........	F	96.10	1.68	2.22	11970	2520	630	1350
	CHESTERTOWN.								
130225	Davis & Satterfield............	G	98.11	0.32	1.57				
	J. J. Buffington & Co..........	F	97.08	0.88	2.04	8100	3690	720	2790
130226	Davis & Satterfield...... ..	G	99⅜	½	⅛				
	J. J. Buffington & Co.........	F	98.54	0.90	0.56	1080	540	0	0
130227	Davis & Satterfield...........	G	98.71	0.97	0.32				
	J. J. Buffington & Co..........	F	97.78	1.40	0.82	2790	1080	0	900
130230	Graham & Clements...........	G	Unlabeled.						
		F	98.56	1.04	0.40	1170	180	0	90
130232	R. F. Parks & Son..............	G	98.00	....	....				
		F	97.40	1.30	1.30	3510	2160	0	0
130234	R. F. Parks & Son..............	G	Unlabeled.						
		F	96.38	0.36	3.26	13140	9270	900	0
130403	R. F. Parks & Son..............	G	Unlabeled.						
		F	98.82	0.62	0.56	1440	90	0	90
	CHURCH HILL.								
130236	E. S. Valliant & Son............	G	98.07	0.80	1.13				
	J. J. Buffington & Co..........	F	93.22	1.22	0.56	1890	1170	0	0
130238	E. S. Valliant & Son............	G	98.77	0.82	0.41				
	J. J. Buffington & Co..........	F	98.32	0.80	0.88	1980	270	0	0
130240	H. E. Wall........................	G	97⅜	1½	1⅛				
	J. J. Buffington & Co.	F	97.14	1.62	1.24	3960	2790	0	90
130241	H. E. Wall........................	G	92½	3	4½				
	J. J. Buffington & Co..........	F	97.02	1.26	1.72	5220	3600	90	540
	CRISFIELD.								
130554	J. P. Tawes & Bro..............	G	98.00	...	....				
	W. A. Simpson & Co.........	F	98.06	1.02	0.92	3870	540	180	1620
	CUMBERLAND.								
130601	W. T. Coulehan & Bro..........	G	95.83	....	2.58				
	Wm. G. Scarlett & Co........	F	95.22	1.86	2.92	15390	1710	1350	5940
130616	Flintstone Hardware Co.......	G	99.36	0.40	0.24				
	J. J. Buffington & Co..........	F	98.78	0.82	0.40	3060	0	0	0
130610	Richards Bros...........	G	.....	....	...				
		F	99.42	0.42	0.16	450	90	0	0

RED CLOVER—CONTINUED.

Lab. No.	Source of Sample. Vendor and Merchant.	Analysis. Per Cent. By Weight.				Some Foreign Seeds. Approximate No. per Lb.			
		Given... Found...	Pure Seed...	Inert Matter..	Foreign Seed...	Total Foreign.	Ripple....	Plantain..	Green Foxtail..
	DENTON.								
130257	Nuttle Hardware Co...........	G	Unlabeled.						
		F	92.78	2.22	5.00	44550	8820	270	900
130441	" "	G	Unlabeled.						
		F	97.36	1.64	1.00	5040	720	0	90
130260	Smith & Walls..................	G	98½	....	....				
	W. A. Simpson & Co..........	F	98.66	0.94	0.40	1580	360	180	270
130261	Smith & Walls..................	G	Unlabeled.						
		F	97.10	1.76	1.14	4500	4140	0	90
	EAST NEW MARKET.								
130479	Saxton & Parker.	G	Unlabeled.						
		F	99.63	0.18	0.19	630	0	0	90
	EASTON.								
130272	Nevius & Frampton............	G	Unlabeled.						
		F	83.90	2.14	13.96	72090	51570	13140	360
130274	N. Tuthill & Son................	G	93.35	1.82	4.84				
	J. J. Buffington & Co..........	F	92.66	3.04	4.30	20340	2610	900	12690
130275	N. Tuthill & Son................	G	Unlabeled.						
	J. J. Buffington & Co..........	F	93.82	2.88	3.30	15300	3690	630	8190
130448	N. Tuthill & Son................	G	95.02	1.45	3.53				
	J. J. Buffington & Co..........	F	94.22	1.82	3.96	19710	270	2700	1890
	FREDERICK.								
13074	Fred'k Co. Farmers' Exchange	G	Unlabeled.						
		F	96.70	2.50	0.80	4590	810	1260	2160
13075	" "	G	Unlabeled.						
		F	94.10	2.30	3.60	13950	11430	180	1800
13076	" "	G	Unlabeled.						
		F	92.60	2.20	5.20	26370	9720	1170	13680
13077	" "	G	Unlabeled.						
		F	93.30	3.80	2.90	11520	3510	1260	3060
13078	" "	G	Unlabeled.						
		F	93.10	1.90	5.00	18000	17460	0	180
13079	" "	G	Unlabeled.						
		F	94.80	3.80	1.40	6570	540	1440	2070
13082	Frederick Grocery Co..........	G	Unlabeled.						
		F	87.90	6.10	6.00	31320	9630	12960	5310
13083	" "	G	Unlabeled.						
		F	93.70	1.80	4.50	25200	7020	9990	4230
13063	P. Hargett & Co................	G	Unlabeled.						
		F	92.80	3.60	3.60	18180	7200	2790	7290
13064	" "	G	Unlabeled.						
		F	95.60	1.36	3.04	15840	5580	4410	4050
13065	" "	G	Unlabeled.						
		F	94.08	1.76	4.16	22500	6570	6660	7650
13066	" "	G	Unlabeled.						
		F	94.00	1.50	4.50	22770	7830	6570	6210

RED CLOVER—CONTINUED.

Leb. No.	Source of Sample. Vendor and Merchant.	Analysis. Per Cent. By Weight.				Some Foreign Seeds. Approximate No. per Lb.			
		Given.... Found....	Pure Seed....	Inert Matter..	Foreign Seed....	Total Foreign.	Ripple....	Plantain..	Green Foxtail..
	FREDERICK—Continued.								
13067	P. Hargett & Co.	G	Unlabeled.						
		F	93.30	2.60	4.10	19890	8100	3690	6750
13068	“ “	G	Unlabeled.						
		F	96.10	2.40	1.50	7380	2610	990	2520
13069	“ “	G	Unlabeled.						
		F	79.82	4.62	15.56	84420	31770	2817	16110
13084	Rhodes R. Kemp	G	Unlabeled.						
		F	94.30	1.50	4.20	15480	13230	630	180
13085	“ “	G	Unlabeled.						
		F	94.50	3.10	2.40	14130	0	180	13680
13080	W. H. Ramsburg	G	Unlabeled.						
		F	76.30	9.60	14.10	71820	63450	720	0
13081	“ “	G	.....	....	....				
		F	78.80	9.00	12.20	40860	22680	0	0
	GREENSBORO.								
130433	C. B. Jarman Wm. G. Scarlett & Co.	G	Unlabeled.						
		F	97.56	1.16	1.28	6300	450	270	5040
	HAGERSTOWN.								
13047	Elliott & Myers	G	Unlabeled.						
		F	96.80	2.20	1.00	2250	0	90	0
13048	“	G	Unlabeled.						
		F	93.40	2.40	4.20	23850	450	6480	10170
13049	“	G	Unlabeled.						
		F	95.10	1.90	3.00	21870	1800	17730	1260
13050	“	G	Unlabeled.						
		F	92.30	4.80	2.90	18270	6300	9360	360
13051	“	G	Unlabeled.						
		F	85.40	4.00	10.60	59490	90	1170	34200
13052	“	G	Unlabeled.						
		F	87.60	5.40	7.00	47700	3510	24480	8730
13053	“	G	Unlabeled.						
		F	96.90	2.10	1.00	5490	270	1890	2340
13054	Elliott & Myers W. H. Small & Co.*	G	Unlabeled.						
		F	98.40	0.84	0.38	3420	0	630	720
13055	Elliott & Myers	G	Unlabeled.						
		F	97.40	1.00	1.60	7560	810	630	5760
13035	Emmert Hardware Co. J. J. Buffington & Co.	G	98.71	0.64	0.65				
		F	98.74	0.76	0.50	1260	540	0	0
13036	Emmert Hardware Co. J. J. Buffington & Co.	G	93.71	0.64	0.65				
		F	99.10	0.50	0.40	810	270	0	0
13037	Emmert Hardware Co.	G	Unlabeled.						
		F	92.28	2.36	5.36	26630	21960	540	2250
13040	“ “	G	Unlabeled.						
		F	92.60	2.40	5.00	22770	2610	630	15840

*Evansville, Indiana.

RED CLOVER—Continued.

Lab. No.	Source of Sample. Vendor and Merchant.	Analysis. Per Cent. By Weight.				Some Foreign Seeds. Appryximate No. per Lb.			
		Given .... Fonnd	Pure Seed....	Inert Matter..	Foreign Seed....	Total Foreign.	Ripple	Plantain ..	Green Foxtail..
	HAGERSTOWN—Continued.								
13041	Emmert Hardware Co.........	G	.....	....	....				
		F	86.80	1.80	11.40	61380	2520	450	90
13042	" "	G	.....	....	....				
		F	96.80	1.40	2.80	15030	6930	4680	270
13043	" "	G	.....	....	....				
		F	97.80	1.20	1.00	3780	810	0	1980
13044	" "	G	.....	....	....				
		F	95.10	2.30	2.60	11520	3690	1800	2250
13045	" "	G	.....	....	....				
		F	94.20	2.40	3.40	13590	11610	990	540
13046	" "	G	.....	....	....				
		F	96.10	2.10	1.80	9450	1260	0	7110
13028	Ernest W. Miller................	G	96.10	0.70	3.20				
		F	97.60	0.40	2.00	9450	4500	180	630
13029	" "	G	96.10	0.70	3.20				
		F	97.60	0.60	1.80	6570	3780	90	180
13030	" "	G	97.86	1.03	1.11				
		F	99.20	0.50	0.30	1350	0	0	90
13031	" "	G	97.43	0.79	1.78				
		F	97.80	0.90	1.30	7650	90	1440	1440
13034	" "	G	99.24	0 59	0.17				
		F	99.30	0.50	0.20	450	180	0	0
1302	Schindel, Rohrer & Co..........	G	Unlabeled.						
		F	99.54	0.30	0.16	990	900	90	0
1303	" "	G	Unlabeled.						
		F	98.24	1.60	0.16	450	0	0	180
1304	" "	G	Unlabeled.						
		F	97.44	1.52	1.04	7020	90	1800	4680
1305	" "	G	Unlabeled.						
		F	82.52	8.22	9.26	66690	360	5760	24210
1306	" "	G	Unlabeled.						
		F	97.04	1.36	1.60	9270	630	1170	6480
1307	" "	G	Unlabeled.						
		F	97.50	1.10	1.40	5310	3150	270	630
1308	" "	G	Unlabeled.						
		F	97.40	0.80	1.80	10440	720	1620	6300
1309	" "	G	Unlabeled.						
		F	97.30	0.80	1.90	7560	6570	0	180
13010	" "	G	94.00	....	....				
		F	97.70	1.10	1.20	6570	810	2340	2520
13011	" "	G	Unlabeled.						
		F	93.00	2.60	4.40	22230	5400	4050	9990
13012	" "	G	Unlabeled.						
		F	92.40	2.50	5.10	27540	7110	7290	10260
13013	" "	G	Unlabeled.						
		F	94.00	1.60	5.00	24930	10710	4050	9000

RED CLOVER—Continued.

Lab. No.	Source of Sample. Vendor and Merchant.	Analysis. Per Cent. By Weight.				Some Foreign Seeds. Approximate No. per Lb.			
		Given ... Found ...	Pure Seed ...	Inert Matter ..	Foreign Seed ...	Total Foreign.	Ripple ...	Plantain ..	Green Foxtail..
	HAGERSTOWN—Continued.								
13014	Schindel, Rohrer & Co.........	G	92.00	....	....				
		F	94.50	1.90	3.60	12240	8100	1080	0
13015	" "	G	Unlabeled.						
		F	96.10	2.00	1.90	9720	4950	0	0
13016	" "	G	Unlabeled.						
		F	90.80	3.80	5.40	21960	8100	0	90
13017	" "	G	88.00	....	....				
		F	92.40	1.40	6.20	38070	14850	18810	1540
13018	" "	G	Unlabeled.						
		F	96.50	1.00	2.50	10890	9900	270	0
13019	" "	G	Unlabeled.						
		F	96.90	0.90	2.20	11250	10710	270	0
13020	" "	G	Unlabeled.						
		F	95.90	1.00	3.10	15480	13770	450	0
	HURLOCK.								
130463	Griffith & Charles........... ..	G	95.83	....	2.58				
	Wm. G. Scarlett & Co........	F	96.32	1.20	2.48	10520	1080	270	7210
130467	W. C. Bradley & Son........ ..	G	.....	....	....				
		F	98.58	0.98	0.44	2430	270	90	90
	LESLIE.								
130393	C. A. Benjamin & Co...........	G	Unlabeled.						
	W. A. Simpson & Co..........	F	95.60	2.24	2.16	11700	2250	990	2430
	POCOMOKE CITY.								
130542	Lloyd & Blaine..................	G	97.00	....	....				
	W. A. Simpson & Co..........	F	96.10	2.04	1.86	8910	1980	540	2430
130526	Peninsula Produce Ex. of Md..	G	Unlabeled.						
		F	96.74	1.58	1.68	10710	1350	90	810
130527	Peninsula Produce " " ..	G	Unlabeled.						
		F	97.78	1.56	0.66	3780	180	1530	80
	PRESTON.								
130451	Garris & Covey................	G	Unlabeled.						
		F	97.86	1.26	0.88	4140	360	900	450
	PRICE.								
130242	W. J. Massey....................	G	98.75	1.00	0.25				
	J. J. Buffington & Co....	F	98.02	1.04	0.94	2970	1170	270	540
130244	W. J. Massey....................	G	Unlabeled.						
		F	97.14	2.06	0.80	2250	810	0	0
130246	W. J. Massey....................	G	Unlabeled.						
	J. J. Buffington & Co..........	F	97.88	1.26	0.86	3600	1800	0	1080
	QUEEN ANNE.								
130437	G. L. Jump......................	G	92.76	....	4.42				
	Wm. G. Scarlett & Co........	F	93.68	2.36	3.95 3.96	20520	1800	360	4320

RED CLOVER—CONTINUED.

Lab. No.	Source of Sample. Vendor and Merchant.	Analysis. Per Cent. By Weight.				Some Foreign Seeds. Approximate No. per Lb.			
		Given.... Found....	Pure Seed....	Inert Matter..	Foreign Seed....	Total Foreign.	Ripple....	Plantain..	Green Foxtail..
	RIDGLEY.								
130264	J. W. Simons....................	G	Unlabeled.						
		F	85.02	6.52	8.46	43830	32490	9900	0
130428	"	G	Unlabeled.						
		F	96.80	2.48	0.72	3240	2790	180	0
130431	J. H. Smith.....................	G	.....	....	....				
		F	95.84	2.06	2.10	11520	1710	630	7020
	SALISBURY.								
130280	L. W. Gunby Co.......... ...	G	Unlabeled.						
		F	93.36	0.64	6.00	20520	19260	0	0
130282	" "	G	Unlabeled.						
		F	93.10	4.44	2.46	15120	2430	0	630
130490	" "	G	Unlabeled.						
		F	94.12	0.42	5.46	18360	18000	0	0
130491	" "	G	Unlabeled.						
		F	95.38	2.26	2.36	12780	1710	0	360
130499	Dorman & Smyth Hdwe. Co...	G	98.00	....	..				
		F	93.00	3.06	3.94	19350	7560	1800	5680
130289	The Farmers' & Planters Co...	G	Unlabeled.						
		F	87.30	2.10	10.60	46170	40230	0	90
	STILL POND.								
130223	Wm. Medders & Co.............	G	98.61	0.70	0.69				
	Wm. G. Scarlett & Co........	F	97.80	0.80	1.40	6660	990	270	1500

CRIMSON CLOVER.

Lab. No.	Source of Sample. Vendor and Merchant.	Percentage by Weight.				Foreign Seeds per Pound.	
		Given.... Found....	Pure Seed	Inert Matter..	Foreign Seed....	Total Foreign.	Yellow Trefoil..
	ANNAPOLIS.						
130556	H. B. Myers Co	G	97.18	1.85	0.97		
	J. J. Buffington & Co.	F	96.51	2.70	0.79	2650	2565
130557	H. B. Myers Co.	G	96.76	....	....		
	W. A. Simpson & Co.	F	97.86	1.56	0.58	2430	0
	BALTIMORE.						
130121	J. Bolgiano & Son	G	95.00	2.67	2.33		
		F	95.21	2.89	1.90	4140	2625
130351	" "	G	97.29	2.39	0.32		
		F	96.83	2.86	0.31	720	225
130352	" "	G	97.29	2.39	0.32		
		F	97.20	2.58	0.22	585	90
100667	" "	G	97.87	1.65	0.48		
		F	97.42	2.27	0.31	900	90
130715	" "	G	97.51	1.42	1.07		
		F	97.26	1.85	0.89	2340	1440
130205	J. J. Buffington & Co.	G	96.11	3.24	0.65		
		F	95.82	3.79	0.39	855	0
130206	" "	G	98.88	0.72	0.40		
		F	98.80	0.69	0.51	1260	540
130322	" "	G	97.25	2.34	0.41		
		F	96.30	3.04	0.66	1485	270
130326	" "	G	98.20	0.82	0.98		
		F	97.85	1.07	1.08	2295	360
130385	" "	G	98.86	0.65	0.49		
		F	97.86	1.94	0.70	1260	720
130386	" "	G	97.11	2.66	0.23		
		F	95.13	3.59	1.28	1170	135
130562	" "	G	98.27	1.33	0.40		
		F	98.39	1.15	0.46	1145	360
130563	" "	G	97.10	1.45	1.45		
		F	96.68	1.73	1.59	5130	4275
130661	" "	G	98.79	0.57	0.64		
		F	97.57	1.64	0.79	1800	900
130716	" "	G	97.03	2.22	0.72		
		F	96.78	2.23	0.99	3150	2475
13088	Griffith & Turner	G	96.50	....	....		
		F	98.33	1.28	0.39	900	0
130106	Meyer-Stisser Co.	G	.....	....	....		
		F	96.01	3.79	0.20	405	0
130173	Wm. G. Scarlett & Co.	G	99.60	0.20	0.20		
		F	99.55	0.35	0.10	270	45
130174	" "	G	95.58	4.02	0.40		
		F	97.18	2.70	0.12	315	135
130175	" "	G	96.61	2.39	1.00		
		F	97.69	1.48	0.83	2790	45

CRIMSON CLOVER—Continued.

Lab. No.	Source of Sample. Vendor and Merchant.	Percentage by Weight.				Foreign Seeds per Pound.	
		Given... Found...	Pure Seed	Inert Matter..	Foreign Seed....	Total Foreign..	Yellow Trefoil..
	Baltimore—Continued.						
130365	Wm. G. Scarlett & Co.	G	95.09	4.51	0.40		
		F	94.35	4.76	0.89	1530	45
130581	" "	G	97.70	1.70	0.60		
		F	97.95	1.19	0.86	2205	1305
130582	" "	G	98.50	1.40	0.10		
		F	97.87	1.39	0.74	2385	855
130673	" "	G	98.21	0.20	1.59		
		F	98.25	0.86	0.89	2340	0
130711	" "	G	98.20	1.30	0.50		
		F	97.22	1.85	0.93	2295	1485
130148	W. A. Simpson & Co.	G	98.83	0.67	0.50		
		F	98.95	0.63	0.42	810	630
130154	" "	G	99.29	0.53	0.18		
		F	98 67	1.09	0.24	630	360
130387	" "	G	97.00	....	....		
		F	96.69	3.10	0.21	450	0
130573	" "	G	96.98	....	....		
		F	96 91	2.66	0.43	1440	270
130574	" "	G	94.52	....	....		
		F	96.46	3.06	0.48	2115	1215
	BERLIN.						
130512	W. R. Purnell Co.	G	98.73	0 65	0.62		
	J. Bolgiano & Son	F	98.39	0.84	0.77	2385	405
	CAMBRIDGE.						
130468	Olin LeCompte	G	97.18	1.85	0.97		
	J. J. Buffington & Co.	F	96.96	2.43	0.61	2745	45
130470	Cambridge Seed & Grocery Co.	G	Unlabeled.				
		F	96.61	2.42	0.97	2340	1980
130474	Cambridge Seed & Grocery Co.	G	98.00	....	1.60		
	Wm. G. Scarlett & Co.	F	97.34	1.69	0.97	3060	2430
130472	Herbert Hearn	G	97.16	....	....		
	W. A. Simpson & Co.	F	96.51	2.27	1.22	3105	2610
	CENTERVILLE.						
130414	P. T. Foreman & Bros.	G	Unlabeled.				
		F	92.48	4.51	3.01	12690	180
130419	P. T. Foreman & Bros.	G	97.40	....	....		
	J. J. Buffington & Co.	F	97.46	1.88	0.66	1845	1485
130415	Wright & Lowe	G	Unlabeled.				
		F	99.27	0.48	0.25	585	0
130418	G. D. Neavitt	G	97.40	....	....		
	J. J. Buffington & Co.	F	97.43	1.41	1.16	3375	2835
130420	"Centerville Wharf"	G					
	Wm. G. Scarlett & Co.	F	97.54	1.48	0.98	3150	2430

CRIMSON CLOVER—CONTINUED.

Lab. No.	Source of Sample. Vendor and Merchant.	Percentage by Weight.				Foreign Seeds per Pound.	
		Given .... Found	Pure Seed	Inert Matter..	Foreign Seed	Totol Foreign.	Yellow Trefoil.
	CHESTERTOWN.						
130400	R. F. Parks & Son	G	98.57	0.95	0.48		
	J. J. Buffington & Co.	F	98.87	0.73	0.90	2835	0
130401	R. F. Parks & Son	G	96.38	3.30	0.32		
	J. J. Buffington & Co.	F	98.03	0.72	1.25	4185	0
130405	Graham & Clements	G	Unlabeled.				
		F	98.99	0.76	0.25	585	45
130406	Davis & Satterfield	G	97.53	1.67	0.80		
	J. J. Buffington & Co.	F	97.62	1.48	0.90	2790	2160
130407	Davis & Satterfield	G	97.40	....	....		
	J. J. Buffington & Co.	F	97.79	1.59	0.62	2115	1710
130409	"Chestertown Wharf"	G	97.53	1.67	0.80		
	J. J. Buffington & Co.	F	96.80	1.17	2.03	6075	5265
	CHURCH HILL.						
130411	H. E. Walls	G	Unlabeled.				
		F	98.70	0.69	0.61	1395	45
	CRISFIELD.						
130552	J. P. Tawes & Bro.	G	97.10	....	....		
	W. A. Simpson & Co.	F	96.52	2.56	0.92	3825	2205
130551	"Crisfield Wharf."	G	98.32	....	....		
	W. A. Simpson & Co.	F	98.14	1.33	0.53	1575	1125
	CUMBERLAND.						
130602	W. T. Coulehan & Bro.	G	97.60	....	0.90		
	Wm. G. Scarlett & Co.	F	97.78	1.43	0.79	2025	1170
130619	Flintstone Hardware Co.	G	96.89	2.92	0.19		
	J. Bolgiano & Son	F	96.31	1.21	2.48	7605	6930
130613	Flintstone Hardware Co.	G	Unlabeled.				
		F	94.97	4.66	0.37	1170	0
	DENTON.						
130442	Nuttall Hardware Co.	G	97.40	....	....		
	J. J. Buffington & Co.	F	96.28	2.07	1.65	4590	4365
	EAST NEWMARKET.						
130478	Saxton & Parker	G	97.18	1.85	0.97		
	J. J. Buffington & Co.	F	97.45	1.97	0.58	1215	90
	EASTON.						
130444	Clark Hardware Co.	G	97.40	....	....		
	J. J. Buffington & Co.	F	97.83	1.46	0.71	1980	1800
130445	Shannahan & Wrightson	G	97.40	....	....		
	J. J. Buffington & Co.	F	96.92	2.40	0.68	1845	1305
	FEDERALSBURG.						
130484	H. F. Stowell & Son	G	97.40	....	....		
	W. A. Simpson & Co.	F	96.99	2.38	0.63	1575	1350
130488	O. G. Williamson	G	97.00	....	....		
	W. A Simpson & Co.	F	96.85	2.34	0.81	1800	1395

CRIMSON CLOVER—CONTINUED.

Lab No.	Source of Sample. Vendor and Merchant.	Percentage by Weight				Foreign Seeds per Pound.	
		Given .... Found	Pure Seed	Inert Matter..	Foreign Seed....	Total Foreign.	Yellow Trefoil..
	PORT DEPOSIT.						
130396	"Wharf."	G	98.00	....	....		
	Griffith & Turner	F	97.06	2.73	0.21	720	135
	FREDERICK.						
13057	A. G. Quinn & Co	G	Unlabeled.				
		F	95.49	4.01	0.50	540	0
13073	P. Hargett & Co	G	Unlabeled.				
		F	96.72	0.67	2.61	4275	0
130644	Frederick County Farmers' Exchange	G	Unlabeled.				
		F	96.04	3.58	0.38	630	0
	GOLDSBORO.						
130434	J. Frank Lane	G	Unlabeled.				
		F	97.54	1.55	0.91	2430	405
	GREENSBORO.						
130432	C. B. Jarman	G	97.00	....	....		
	Capelle Hardware Co., Wilmington, Del.	F	99.00	0.77	0.23	720	45
	HAGERSTOWN.						
130630	Ernest W. Miller	G	96.89	2.92	0.19		
	J. Bolgiano & Son	F	97.98	1.58	0.44	720	90
	HILLSBORO.						
130425	Stewart & Jarrell	G	97.40	....	....		
	J. J. Buffington & Co.	F	97.52	1.88	0.60	1755	1485
	HURLOCK.						
130462	Griffith & Charles	G	97.60	....	0.10		
	Wm. G. Scarlett & Co.	F	97.81	1.17	1.02	3105	2620
130465	W. C. Bradley & Son	G	97.40	....	....		
	J. J. Buffington & Co.	F	96.44	1.42	2.14	6660	6165
	KINGS CREEK.						
130555	"Freight Depot."	G	97.51	....	....		
	W. A. Simpson & Co	F	97.21	1.83	0.96	3240	1305
	LESLIE.						
130395	C. A. Benjamin & Co.	G	.....	....	....		
	W. A. Simpson & Co.	F	98.66	0.89	0.45	1530	585
	POCOMOKE CITY.						
130523	W. S. Schoolfield Co.	G	97.50	....	....		
	W. A. Simpson & Co	F	96.58	2.27	1.15	2655	1980
130524	Peninsula Produce Exchange	G	97.00	....	....		
		F	97.87	1.87	0.26	720	360
130536	N. Davis	G	Unlabeled.				
		F	99.39	0.58	0.03	225	45
130537	" "	G	.....	....	....		
		F	97.12	2.00	0.88	2835	2745
130540	Lloyd & Blaine	G	99.72	....	....		
	Nungesser-Dickinson Co., N. Y.	F	99.31	0.60	0.09	225	0

CRIMSON CLOVER—Continued.

Lab. No.	Source of Sample. Vendor and Merchant.	Percentage by Weight.				Foreign Seeds per Pound.	
		Given .... Found	Pure Seed	Inert Matter..	Foreign Seed	Total Foreign.	Yellow Trefoil..
	Pocomoke City—Continued.						
130547	Lloyd & Blaine	G	96.59	....	....		
	W. A. Simpson & Co	F	97.20	1.87	0.93	3015	1980
	PRESTON.						
130454	J. A. Cox	G	98.00	....	1.40		
	Wm. G. Scarlett & Co	F	97.09	2.26	0.65	1620	1305
	PRINCESS ANNE.						
130550	C. H. Hayman	G	Unlabeled.				
	Nungesser-Dickinson Co., N. Y	F	97.79	2.08	0.13	630	180
	QUEEN ANNE.						
130436	G. L. Jump	G	97.40	....	....		
	J. J. Buffington & Co	F	97.23	1.78	0.99	3105	2790
	RIDGELY.						
130263	J. W. Simons	G	Unlabeled.				
	J. Bolgiano & Son	F	97.37	2.45	0.18	360	0
130426	J. W. Simons	G	Unlabeled.				
		F	92.11	1.47	6.42	43650	0
130265	W. T. Temple	G	98.80	0.72	0.40		
	J. J. Buffington & Co	F	98.62	0.77	0.61	1170	450
	SALISBURY.						
130281	L. W. Gunby Co	G	Unlabeled.				
		F	97.98	1.73	0.29	630	45
130284	" "	G	Unlabeled.				
		F	96.75	2.43	0.82	1890	225
130493	" "	G	Unlabeled.				
		F	96.47	1.79	1.74	3240	855
130494	" "	G	Unlabeled.				
		F	98.20	1.08	0.72	3510	45
130498	Dorman & Smyth Hardware Co	G	96.56	....	....		
	W. A. Simpson & Co	F	96.63	2.35	1.02	4320	2070
130505	Farmers & Planters' Co	G	97.18	1.85	0.97		
	J. J. Buffington & Co	F	96.44	2.36	1.20	3510	2745
	SNOW HILL.						
130519	Hastings & Timmons	G	97.18	1.85	0.97		
	J. J. Buffington & Co	F	97.81	1.49	0.70	1980	1665
130520	C. S. Timmons	G	97.90	1.62	0.48		
	J. J. Buffington & Co	F	98.47	1.20	0.33	1035	585
	VIENNA.						
130455	J. W. T. Webb & Son	G	97.40	....	....		
	J. J. Buffington & Co	F	97.79	1.18	1.03	3240	2790
130460	Winfield, Webster & Co	G	Unlabeled.				
		F	96.22	3.20	0.58	1260	180

WHITE CLOVER.

Lab. No.	Source of Sample. Vendor and Merchant.	Analysis. Per Cent. By Weight.				Certain Foreign Seed. Per Cent. By Count.		
		Given........ Found........	Pure Seed....	Inert Matter..	Foreign Seed........	Alsike and Timothy	Sheep Sorrel..	Yellow Trefoil......
	BALTIMORE.							
130129	J. Bolgiano & Son..........................	G	92.11	0.88	7.01			
		F	96.66	1.06	2.27	45.3	36.8	5.1
130130	" "	G	88 50	1.68	9.87			
		F	88.97	3.70	7.33	7.1	45.8	9.9*
130195	J. J. Buffington & Co......................	G	99.00	0.10	0.90			
		F	98.87	0.40	0.73	60.0	32.7	0.0
13086	Griffith & Turner Co......................	G	94.50	....	....			
		F	97.89	0.21	2.90	58.9	19.4	9.3
130103	Meyer-Stisser Co..........................	G	.....	....	....			
		F	97.20	0.80	2.00	0.0	8.3	0.0**
130179	Wm. G. Scarlett & Co......................	G	97.00	0.50	2.50			
		F	97.50	0.57	1.93	40.5	50.0	1.6
130368	" "	G	96 27	1.24	2.49			
		F	96.31	1.36	2.33	17.2	61.1	0.0
130143	W. A. Simpson & Co.......................	G	98.39	0.68	0.93			
		F	93.97	2.03	4.00	15.4	52.2	3.6
130144	" "	G	98.47	0.20	1.33			
		F	98.34	0.63	1.03	50.0	22.4	22.4
	FREDERICK.							
13062	A. G. Quynn & Co..........................	G	.....	....	....			
		F	88.31	2.96	8.73	46.2	41.8	0.4
	HAGERSTOWN.							
13033	E. W. Miller................................	G	97.40	2.90	0.70			
		F	98.01	1.76	0.13	0.0	9.1	0.0
	POCOMOKE CITY.							
130532	Peninsula Produce Exchange.............	G	.....	....	....			
		F	95.40	2.00	2.60	33.1	43.1	8.5

*Ripple 25.1%.
**Ripple 76.7%.

ALSIKE.

Lab. No.	Source of Sample. Vendor and Merchant.	Analysis. Per Cent. By Weight.				Certain Foreign Seeds. Per Cent. By Count.		
		Given / Found	Pure Seed	Inert Matter	Foreign Seed	White Clover and Timothy	Sheep Sorrel	Yellow Trefoil
	ANNAPOLIS.							
130314	H. B. Myers Co.	G	......	....	......			
		F	97.07	0.66	2.27	77.2	6.2	6.2
	BALTIMORE.							
130125	J. Bolgiano & Son	G	97.57	0.40	2.03			
		F	95.87	1.27	2.86	62.0	22.9	0.0
130131	" "	G	......	......	......			
		F	96.79	0.67	2.54	70.1	24.0	0.0
130199	J. J. Buffington & Co.	G	87.80	0.82	11.38			
		F	88.48	1.76	9.76	93.9	0.0	1.8
130200	" "	G	98.98	0.20	0.82			
		F	98.03	0.50	1.47	90.0	0.0	3.6
13092	Griffith & Turner Co.	G	94.00	......	......			
		F	96.97	0.50	2.53	66.0	27.7	0.0
130169	Wm. G. Scarlett & Co.	G	96.02	1.49	2.49			
		F	96.19	1.15	2.66	88.0	0.6	1.8
130170	" "	G	97.26	1.49	1.25			
		F	97.13	1.07	1.80	99.1	0.9	0.0
130216	" "	G	96.88	0.87	2.25			
		F	96.31	0.83	2.86	65.3	7.6	9.0
130367	" "	G	98.02	0.25	1.73			
		F	98.34	0.30	1.36	46.6	24.0	0.0
130579	" "	G	99.26	0.12	0.62			
		F	99.17	0.23	0.60	47.3	0.0	0.0
130676	" "	G	98.02	0.49	1.49			
		F	97.80	0.87	1.33	29.8	9.5	0.0
130686	" "	G	95.05	1.49	3.46			
		F	94.14	1.63	4.23	39.6	0.5	19.8
130687	" "	G	98.01	0.50	1.49			
		F	98.40	0.40	1.20	31.9	63.8	0.0
130688	" "	G	95.54	0.99	3.47			
		F	95.54	0.96	3.50	94.5	0.6	1.8
130145	W. A. Simpson & Co.	G	96.75	0.35	2.90			
		F	96.84	0.86	2.30	58.4	11.2	11.2
130146	" "	G	93.74	0.89	5.37			
		F	94.16	1.00	4.84	62.0	21.1	1.0
	BETTERTON.							
130221	Turner & Son	G	90.17	0.81	9.02			
	J. J. Buffington & Co.	F	89.44	0.63	9.93	95.8	0.0	2.5

ALSIKE—CONTINUED.

Lab. No.	Source of Sample. Vendor and Merchant.	Analysis. Per Cent. By Weight.				Certain Foreign Seeds. Per Cent. By Count.		
		Given / Found	Pure Seed	Inert Matter	Foreign Seed	White Clover and Timothy	Sheep Sorrel	Yellow Trefoil
	CAMBRIDGE.							
130296	Oliver Spedden	G	98.98	0.20	0.82			
	J. J. Buffington & Co.	F	98.00	0.50	1.50	98.6	0.0	6.6
130299	Cambridge Seed & Grocery Co.	G	......	......	......			
	J. J. Buffington & Co.	F	90.30	1.90	7.80	42.3	40.4	......
	CENTERVILLE.							
130247	P. T. Foreman & Bro.	G	88.66	3.65	7.69			
	J. J. Buffington & Co.	F	83.50	7.17	9.33	43.8	12.8	0.0*
130253	G. D. Neavitt	G	91.00	⅞	8⅛			
	J. J. Buffington & Co.	F	85.94	3.40	10.66	62.4	3.9	1.1
	CHESTERTOWN.							
130402	R. F. Parks & Son	G	86.00	0.60	13.40			
	J. J. Buffington & Co.	F	84.97	1.00	14.03	78.7	15.1	......
	CHURCH HILL.							
130239	E. S. Valliant & Son	G	89.00	1.20	9.80			
	J. J. Buffington & Co.	F	88.68	0.70	10.62	68.8	22.1	1.0
	CUMBERLAND.							
130598	W. T. Coulehan & Bro.	G	......	......	......			
		F	89.94	2.16	7.90	61.5	11.1	1.7
	DENTON.							
130255	Nuttle Hardware Co.	G	93.60	1.48	4.92			
	Wm. G. Scarlett & Co.	F	93.94	0.86	5.20	85.6	6.5	1.5
	EASTON.							
130273	Clark Hardware Co.	G	......	......	......			
		F	98.27	0.33	1.40	73.8	0.0	4.7
130270	Shannahan & Wrightson Hardware Co.	G	97.50	0.75	1.75			
		F	87.92	1.70	10.38	54.7	38.7	0.0
	FEDERALSBURG.							
130485	Covey & Williams	G	......	.....	......			
		F	94.64	1.40	3.96	72.4	7.1	8.0
	FREDERICK.							
13071	P. Hargett & Co.	G	95.25	1.00	3.75			
	J. J. Buffington & Co.	F	95.80	0.77	3.43	63.4	28.1	0.0
13061	A. G. Quynn & Co.	G	......	......	......			
		F	97.48	0.42	3.10	77.8	11.8	0.0
130636	" "	G	......	......	......			
		E	98.84	0.26	0.90	82.6	0.0	0.0

*24.2% Virginia peppergrass.

ALSIKE—CONTINUED.

Lab. No.	Source of Sample. Vendor and Merchant.		Analysis. Per Cent. By Weight.			Certain Foreign Seeds. Per Cent. By Count.		
		Given / Found	Pure Seed	Inert Matter	Foreign Seed	White Clover and Timothy	Sheep Sorrel	Yellow Trefoil
	GOLDSBORO.							
130267	J. F. Lane	G						
		F	97.77	0.33	1.90	85.8	5.8	1.3
	HAGERSTOWN.							
13024	E. W. Miller	G	98.24	1.55	0.21			
	W. H. Small & Co-	F	97.60	1.57	0.83	90.0	6.0	0.0
13021	Schindel, Rohrer & Co	G						
		F	90.35	1.92	7.73	87.1	7.3	0.0
13039	Emmert Hardware Co	G						
		F	95.67	0.83	3.50	62.3	26.1	0.0
	LESLIE.							
130391	C. A. Benjamin & Co	G						
	W. A. Simpson & Co	F	98.11	0.73	1.16	89.5	0.0	0.0
	PRESTON.							
130452	Garris & Covey	G						
		F	82.38	2.96	14.66	60.9	10.0	1.3
	PRICE.							
130245	W. J. Massey	G						
		F	87.71	0.53	11.76	65.4	24.2	0.6

ALFALFA.

Lab. No.	Source of Sample. Vendor and Merchant.	Analysis. Per Cent. By Weight.				Approx. No. of Foreign Seebs per Lb.
		Given / Found	Pure Seed	Inert Matter	Foreign Seed	
	ANNAPOLIS.					
130310	H. B. Myers Co.	G	99.00	....	....	
	W. A. Simpson & Co.	F	99.15	0.65	0.20	728
130560	H. B. Myers Co.	G	99.00	....	....	
		F	98.85	0.50	0.65	1400
	BALTIMORE.					
130120	J. Bolgiano & Son	G	98.14	1.30	0.56	
		F	96.92	2.78	0.30	728
130356	" "	G	99.27	0.40	0.33	
		F	98.52	1.33	0.15	336
130590	" "	G	....	....	....	
		F	98.89	0.91	0.20	448
130688	" "	G	99.38	0.56	0.06	
		F	99.16	0.43	0.41	1176
130669	" "	G	99.42	0.48	0.10	
		F	98.82	0.96	0.22	616
130712	" "	G	99.70	0.18	0.12	
		F	99.01	0.67	0.32	784
130713	" "	G	99.25	0.75	0.00	
		F	98.31	1.62	0.07	280
130203	J. J. Buffington & Co.	G	99.91	0.05	0.04	
		F	99.84	0.02	0.13	112
130564	" "	G	99.52	0.43	0.05	
		F	99.31	0.41	0.28	896
130595	" "	G	....	....	....	
		F	94.81	1.47	3.72	10416
130657	" "	G	99.28	0.40	0.32	
		F	98.89	0.68	0.43	1176
130695	" "	G	99.80	0.16	0.04	
		F	99.61	0.33	0.06	112
13087	Griffith & Turner Co.	G	97.50	....	....	
		F	98.84	0.77	0.38	1288
130171	Wm. G. Scarlett & Co.	G	99.50	0.20	0.30	
		F	99.37	0.50	0.17	392
130172	" "	G	99.65	0.25	0.10	
		F	99.37	0.42	0.21	728
130580	" "	G	98.60	1.00	0.40	
		F	99.17	0.68	0.15	280
130672	" "	G	99.60	0.30	0.10	
		F	99.62	0.37	0.01	112
130684	" "	G	97.61	1.99	0.40	
		F	98.86	0.82	0.32	1232
130707	" "	G	99.30	0.60	0.10	
		F	99.07	0.93	0.00	0

ALFALFA—CONTINUED.

Lab. No.	Source of Sample. Vendor and Merchant.	Analysis. Per Cent. By Weight.				Approx. No. of Foreign Seeds per Lb...
		Given......... Found.........	Pure Seed....	Inert Matter...	Foreign Seed...	
	Baltimore—Continued.					
130142	W. A. Simpson & Co	G	98.93	0.81	0.26	
		F	97.93	1.45	0.62	1456
130157	" "	G	98.59	0.38	1.03	
		F	99.24	0.58	0.18	1064
130381	" "	G	.....	....	....	
		F	97.16	2.13	0.71	2520
130577	" "	G	99.59	....	....	
		F	99.30	0.40	0.30	560
	CAMBRIDGE.					
130297	Cambridge Seed & Grocery Co	G	.....	....	....	
	Wm. G. Scarlett & Co	F	99.17	0.56	0.27	1120
	CENTERVILLE					
130417	Wright & Lowe	G	98.50	....	....	
	W. A. Simpson & Co	F	98.55	0.65	0.80	2800
	CUMBERLAND.					
130596	W. T. Coulehan & Bro	G	97.61	1.99	0.40	
	Wm. G. Scarlett & Co	F	95.84	3.78	0.38	728
130316	Flintstone Hardware Co	G	99.65	....	0.10	
	Wm. G. Scarlett & Co	F	99.67	0.32	0.01	280
130609	Richards Bros	G	.....	....	....	
		F	98.98	0.74	0.28	560
	DENTON.					
130438	Nuttall Hardware Co	G	94.13	0.89	4.98	
	J. J. Buffington & Co	F	95.23	1.30	3.47	9408
	EASTON.					
130443	Clark Hardware Co	G	99.20	0.48	0.32	
	J. J. Buffington & Co	F	98.57	0.97	0.46	1400
130276	N. Tuthill & Son	G	99.20	0.48	0.32	
	J. J. Buffington & Co	F	98.96	0.78	0.26	1120
130446	N. Tuthill & Son	G	99.91	0.05	0.04	
	J. J. Buffington & Co	F	99.70	0.20	0.10	224
	FREDERICK.					
130643	Fred, County Farmers Exchange	G	.....	....	....	
		F	98.77	0.73	0.50	1344
13059	A. G. Quynn & Co	G	.....	....	....	
		F	98.77	0.97	0.25	616
130632	" "	G	.....	....	....	
		F	99.35	0.32	0.33	1064

ALFALFA—CONTINUED.

Lab. No.	Source of Sample. Vendor and Merchant.	Analysis. Per Cent. By Weight. Given..... Found.....	Pure Seed.....	Inert Matter....	Foreign Seed...	Approx. No. of Foreign Seeds per Lb....
	HAGERSTOWN.					
13056	Elliott & Myers...............	G	.....	....	....	
	W. H. Small & Co.*...............	F	97.22	2.12	0.66	1400
13027	Ernest W. Miller...............	G	.....	....	....	
		F	98.46	1.16	0.38	840
130628	Ernest W. Miller...............	G	.....	....	....	
	W. H. Small & Co...............	F	98.42	1.25	0.33	784
13023	Schindel, Rohrer & Co...............	G	.....	....	....	
	W. H. Small & Co...............	F	97.83	1.53	0.62	1288
	POCOMOKE CITY.					
130539	N. Davis...............	G	.....	....	....	
		F	97.41	1.99	0.61	1568
130535	Peninsula Produce Exchange...............	G	.....	....	....	
		F	98.39	1.26	0.35	728
	SALISBURY.					
130503	Farmers & Planters Co...............	G	.....	....	....	
		F	99.47	0.32	0.21	616
	SNOW HILL.					
130514	Thos. P. Selby...............	G	....	....	....	
		F	99.34	0.51	0.15	560

*Evansville, Ind.

HAIRY VETCH.

Lab. No.	Source of Sample. Vendor and Merchant.	Percentage by Weight.				Seeds per Pound.			
		Given.... Found....	Pure Seed....	Inert Matter..	Foreign Seed....	Spring Vetch..	Mottled Vetch..	Black Vetch..	Corn Cockle..
	ANNAPOLIS.								
130558	H. B. Myers Co..................... W. A. Simpson & Co......	G F	..... 98.82	.... 0.52	.... 0.66	27	99	0	0
	BALTIMORE.								
130114	J. Bolgiano & Son..................	G F	92.74 89 80	0.17 0.31	7.09 9.86	72	729	1161	36
130118	" "	G F	76.28 76.76	0.23 0.32	23.49 22.92	558	1557	2331	72
130339	" "	G F	98.24 98.89	0.17 0.56	1.59 0.55	9	36	0	0
130338	John J. Buffington & Co...........	G F	98.50 98.50	0.48 0.70	1.02 0.90	45	162	0	9
130566	" "	G F	98.93 98.60	0.28 0.48	0.79 0.92	27	144	0	27
130694	" "	G F	85.30 84.73	0.42 0.79	14.28 14.48	846	855	756	405
130105	Meyer-Stisser Co..................	G F	..... 99.48	.... 0.36	.... 0.16	0	18	0	9
130176	Wm. G. Scarlett & Co..............	G F	98.21 98.61	0.18 0.49	1.61 0.96	0	108	0	216
130177	" "	G F	86.17 88.53	0.28 1.25	13.55 10.22	117	783	1242	99
130366	" "	G F	99.10 98.91	0.07 0.25	0.83 0.84	9	90	0	0
	DENTON.								
130440	Nuttall Hardware Co...............	G F	..... 97.55	.... 0.32	.... 2.13	72	153	0	189
	SALISBURY.								
130497	Dorman & Smyth Hardware Co... W. A. Simpson & Co............	G F	99.41 99.05	.... 0.38	.... 0.57	0	27	0	0

THE MARYLAND AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 180 MARCH 1914.

TOMATO VARIETY AND PLANTING TESTS.

By Thomas H. White.

Variety Tests.

The practice of seedsmen in sending out annually, many new, or so-called new varieties, seems to keep up, and in fact stimulate, the interest in novelties of not only tomatoes, but all classes of plants. This Experiment Station has deemed it necessary to try some of these, as they are introduced, along with some of the old standard kinds. Bulletin No. 113, published in December, 1908, contains the last tomato report issued. The figures published herewith are what have accumulated since that time.

In studying the following tables it will be well to bear in mind that it is better not to base conclusions on the behavior of one variety for one season. For this reason averages for several seasons have been computed wherever possible. It is believed that this is about the only way that a fair idea of their merits can be obtained.

It frequently happens that varieties as they come from the seedsmen are incorrectly named. In making these tests the varieties have been purchased each year from the introducers of the variety. It was thought by this means that the stock would be more likely to be true to name.

Varieties that have well-marked characters, such as different colored fruits or different shaped leaves, can be easily indentified. Others that have no prominent characters can not be identified except by experts. Varieties like Stone, Matchless, Kelly Red, and many other of the same type could be easily substituted one for the other.

During the past twenty years the progress toward the ideal tomato for canning has not been rapid. The variety Stone came into the market twenty-three or four years ago. It became then, and still is, one of the foremost varieties used for canning. There are many others quite similar to it that are also in the canning class. There is a need for a tomato for canning that while possessing all the good points of the present standard varieties, should also have one or two others that would very much improve it. One very important point would be for the fruit to be globe to conical in shape rather than flat. If the stem were supported on a slight neck rather than in a depression there would be much less waste in peeling.

Greater Baltimore, a very valuable variety, that has shown up well in the tests for several years, is defective by having a slight depression on the blossom end. A full rounded surface would be much better.

The fruit of the variety Coreless is nearer to the ideal in shape. The branches, however, are sprawling in habit and the joints and flower clusters are far apart. It is also late in producing fruit. There are several varieties that have the neck, notably those designated as pear shaped, but of course these are too small for canning uses. Some crosses have already been made at this Station, with the hope that this desirable character can be blended with the desirable characters of the Stone types. There is no notable advance towards smoothness and earliness other than Sparks Earliana, which was introduced about fifteen years ago. This variety seems to be very well fixed in character and continues to do well. It is a standard for earliness and a short season. Many of the early tomatoes now offered are this variety under another name. Two other early varieties deserving of mention are Bonny Best and Chalks Early Jewel. They have the fruit characters of the Stone with not quite such vigorous habit of growth. Earliness also seems to be blended with this. They are grown for the canning trade on some of the sandy soils of the Eastern Shore and are quite productive.

Experiment With Early Versus Late Planting.

On page 101 of Bulletin No. 113, the last publication on tomatoes issued from this Station, mention is made of a test between plants grown by sowing seed early in a hot-bed against plants sown in a sheltered location later. For the early planting the seeds were sown in a hot-bed the first week in March and transplanted to another mild one early in April.

The plants were set 4x5 inches apart. About the tenth of May they were taken up with a block of earth attached and set into prepared ground in the field.

The yields from these can be found in the tables under the heading early planted. Those grown for the later planting were sown about second week in April in the open ground. They were covered with glass sash until well up, after which the sash were removed so that the plants would be as stocky as possible. These plants were usually set in the field at the same time as the early planted lot. They, however, were drawn from the bed and planted with a peg. The preparation of soil and the cultivation were in all other respects the same. The annual yields of the varieties tested both on the early and late planting will be found in the Tables I to VII.

In Table VIII the yields of eight standard varieties for seven seasons have been placed together for comparison. The totals have been found and the average computed for each season as well as the seven seasons.

There is a balance of 1.2 tons per acre in favor of the early planted with the varieties and seasons tried.

Table IX is arranged for an easy comparison of some standard varieties grown for several seasons, both early and late planted. It was thought that by adding the annual yields per acre together, and dividing them by the number of seasons grown, that the result would be an average indication of what the variety would do.

Table X is arranged so that one variety can be easily compared with another the same season or various seasons.

Table XI is a copy from the files of the United States Weather Service of the amount of rainfall in inches as observed at this Station for the months and years of the seasons during which the tests were made.

TABLE I. COMPARISON OF THE VARIETIES OF TOMATOES TESTED IN 1907. SIZE OF PLOTS 100 SQ. FT.

VARIETIES	Date of First Picking	Date of Last Picking	Number of Fruits	Yield Per Plot Lbs. Oz.	Average Weight Oz.	Yield Per Acre Tons.
EARLY PLANTED.						
June Pink..	7/20	8/22	160	33.8	4.3	7.2
Earliest Pink	7/20	8/22	170	37.4	5.5	8.1
Sparks Earliana..	7/20	8/22	217	54.4	4.0	11.7
Acme	8/7	8/29	108	23.8	3.4	5.1
Beauty	8/7	8/29	133	40.00	4.8	8.7
Globe	8/7	9/13	130	60.2	7.3	13.0
Greater Baltimore..	8/7	9/13	170	56.4	5.3	12.1
Chalks Early Jewel	8/7	9/13	146	46.8	5.0	10.1
Allens Best	8/7	9/13	154	43.8	4.5	9.4
Paragon	8/7	9/13	156	45.8	4.6	9.3
Matchless	8/7	9/13	153	50.2	5.3	10.9
Stone	8/7	9/13	134	47.0	5.6	10.2
Success	8/7	9/13	135	39.4	4.6	8.0
Five Million Dollar	8/7	9/13	122	35.12	4.5	7.7
Red Rock	8/12	9/13	168	49.4	4.6	10.7
LATE PLANTED.						
Matchless	9/6	10/6	117	36.8	4.2	7.9
Paragon	9/6	10/6	124	38.4	4.9	8.3
Five Million Dollar	9/6	10/6	75	26.8	5.6	5.7
Greater Baltimore	9/6	10/6	138	46.8	5.3	10.1
Stone	9/6	10/6	111	37.0	5.3	8.0

TABLE II. COMPARISON OF THE VARIETIES OF TOMATOES TESTED IN 1908. SIZE OF PLOTS 100 SQ. FT.

VARIETIES	Date of First Picking	Date of Last Picking	Number of Fruits	Yield Per Plot Lbs. Oz.	Average Weight Oz.	Yield Per Acre Tons
EARLY PLANTED						
Earliest of all	7/8	8/13	123	32.8	4.3	7 0
June Pink	7/8	8/13	139	37.8	4.3	8.1
Sparks Earliana	7/8	8/13	118	30.4	4.1	6.5
Jack Rose	7/8	8/13	149	39.2	4.2	8.4
Paragon	7/8	9/25	277	69.0	4 0	15.0
Blight-proof	7/8	9/25	208	50.4	3.8	10.9
Matchless	7/17	9/25	237	58.4	3.9	12.6
Five Million Dollar	7/11	9/25	238	59 12	4.0	12.9
Globe	7/11	9/25	211	53.12	4.1	11.6
Bonny Best	7/11	9/25	234	59.8	4 1	12.9
Acme	7/8	9/25	360	76.0	3.3	16 5
Greater Baltimore	7/11	9/25	223	57.2	4.1	12.4
Coreless	7/17	9/25	198	51.4	4.5	11.1
Chalks Early Jewel	7/8	9/25	217	50.12	3 7	11.0
Hummer	7/17	9/25	291	50.2	2.8	10.9
Beauty	7/8	9/25	234	43.0	2.9	9.3
LATE PLANTED						
Greater Baltimore	8/20	10/2	219	68.0	4.9	14.7
Paragon	8/20	10/2	129	43.8	5.3	9.4
Matchless	8/20	10/2	114	44.8	6.2	9.6
Five Million Dollar	8/20	10/2	113	40.2	5.6	8.2

TABLE III. COMPARISON OF THE VARIETIES OF TOMATOES TESTED IN 1909. SIZE OF PLOTS 100 SQ. FT.

VARITIES	Date of First Picking	Date of Last Picking	Number of Fruits	Yield Per Plot Lbs. Oz.	Average Weight Oz.	Yield per Acre Tons
EARLY PLANTED						
Red Rock	7/17	9/15	310	109.0	5.8	23.7
Dwarf Giant	7/17	8/30	200	74.4	5.9	16.1
Wealthy	7/12	8/17	367	93.8	4.0	20.3
Sparks Earliana	7/12	8/24	405	108.0	4.2	23.4
Gordoniers Earliana	7/12	8/17	562	95.0	2.8	20.6
Jack Rose	7/12	8/17	321	62.0	3.0	13.4
Earliest of all (Salzer)	7/12	8/17	162	31.12	3.2	6.2
Chalks Early Jewel	7/17	9/15	343	98.8	4.5	21.4
Beauty	7/17	8/24	244	60.0	4.0	13.0
Bonny Best	7/17	8/24	333	72.12	3.5	15.8
Stone	7/17	8/24	203	45.0	3.5	9.7
Five Million Dollar	7/17	8/30	302	48.4	2.5	10.4
Hummer	7/17	8/30	195	34 12	2.8	7.5
Paragon	7/17	8/30	165	26.0	2.7	5.6
Greater Baltimore	7/17	8/24	267	61.8	3.6	13.3
Globe	7/17	8/24	156	32.4	3.3	7.0
Coreless	7/17	8/30	103	23.8	3.5	5.1
Redfield Beauty	7/17	8/30	167	31.4	3.0	6.7
LATE PLANTED						
Five Million Dollar	8/13	9/15	203	65.4	5.3	14.1
Matchless	8/7	9/12	131	40.12	5 0	9.3
Greater Baltimore	8/7	9/12	231	46.4	3.1	10.5
Paragon	8/7	9/15	154	47.12	5.0	10.3
Stone	8/8	9/12	192	67.4	5.5	14.6

TABLE IV. COMPARISON OF THE VARIETIES OF TOMATOES TESTED IN 1910. SIZE OF PLOT 100 SQ. FT.

VARIETIES	Date of First Picking	Date of Last Picking	Number of Fruits	Yield Per Plot Lbs. Oz.	Average Weight Oz.	Yield Per Acre Tons
EARLY PLANTED						
Coreless	8/1	9/6	195	50.4	4.1	10.9
Crimson Robe	7/16	8/27	204	52...	4.0	11.4
Florida Special	7/20	8/27	137	40.12	4.7	8.8
My Maryland	8/8	9/6	70	20.12	3.3	4.5
Red Rock	7/20	9/2	89	31.12	5.6	6.9
Ten Ton	7/27	9/6	208	57.12	4.4	12.5
Bonny Best	7/9	8/27	178	55.4	4.9	12.0
Dwarf Giant	7/20	8/27	84	27.8	5.2	5.9
Hummer	7/27	9/6	262	71...	4.3	14.4
Matchless	7/20	9/6	148	48.8	5.2	10.5
Paragon	7/23	9/6	239	63.4	4.2	13.7
Redfield Beauty	7/27	9/6	187	46.8	4.0	10.1
Stone	7/20	9/6	210	65.12	5.0	14.2
Gordoniers Earliana	7/20	9/2	139	42.8	4.2	9.2
Sparks Earliana	7/16	8/27	168	44.8	4.2	9.6
Wealthy	7/16	8/19	146	32.12	4.5	7.1
La Crosse	7/20	8/27	142	27.12	3.1	6.0
LATE PLANTED						
Red Rock	8/8	9/16	138	41.2	4.7	8.9
Bonny Best	7/27	9/16	103	31.2	4.7	6.7
Coreless	8/12	9/16	77	23.8	4.8	5.1
Matchless	8/1	9/16	152	54.4	5.6	11.2
Stone	8/1	9/16	113	37.4	5.2	8.1
My Maryland	8/1	9/16	150	48.8	5.1	10.4

TABLE V. COMPARISON OF THE VARIETIES OF TOMATOES TESTED IN 1911. SIZE OF PLOTS 100 SQ. FT.

VARIETIES	Date of First Picking	Date of Last Picking	Number of Fruits	Yield Per Plot Lbs. Oz.	Average Weight Oz.	Yield Per Acre Tons
EARLY PLANTED						
Ponderosa	7/10	8/9	36	11.4	5.0	2.4
Favorite	7/6	8/9	51	8.12	2.5	1.9
Hummer	7/6	8/9	79	11.8	2.3	2.5
My Maryland	7/10	8/9	60	10.8	2.8	2.2
Coreless	7/19	8/9	20	5.12	4.6	1.1
Matchless	7/10	8/9	77	13 8	2.8	2.9
Globe	7/6	8/9	47	8.12	3.0	1.9
Beauty	7/10	8/9	82	15.8	3.0	3.3
Tenderloin	7/10	8/9	86	17.12	3.3	3.8
Stone	7/19	8/9	63	12.8	3.1	2.7
Greater Baltimore	7/10	8/9	69	13.12	3.3	2.9
Keily Red	7/10	8/9	47	9.2	3.1	1.9
Paragon	7/10	8/9	63	8.8	2.1	1.8
Redfield Beauty	7/10	8/9	49	6.12	2.2	1.4
Crimson Robe	7/6	8/9	73	9.12	2.1	2.1
Ten Ton	7/10	8/9	79	11.8	2.3	2.5
Florida Special	7/6	8/9	66	11.12	2.8	2.5
Chalks Early Jewel	7/6	8/9	91	16.4	2.8	3.5
Bonny Best	7/6	8/9	83	18.12	2.4	4.0
Sparks Earliana	7/6	8/9	109	20.8	3.0	4.4
Langdons Earliana	7/6	8/9	68	13.2	3.0	2.8
Fields Early June	7/6	8/7	114	16.4	2.2	3.5
LaCross	7/6	8/9	58	8.8	2.4	1.8
Cracker Jack	7/19	8/9	98	10.0	1.6	2.1
Maules Earliest	7/6	8/9	85	15.12	3.0	3.4
Burpees Early Giant	7/10	8/9	46	12.00	4.2	2.6

TABLE VI. COMPARISON OF THE VARIETIES OF TOMATOES TESTED IN 1912. SIZE OF PLOTS 100 SQ. FT.

VARIETIES	Date of First Picking	Date of Last Picking	Number of Fruits	Yield Per Plot Lbs. Oz.	Average Weight Oz.	Yield per Acre Tons
EARLY PLANTED.						
Carters Sunrise	7/12	9/13	203	21.4	1 6	4.6
Matchless	7/18	9/13	79	21.2	4.3	4.5
Paragon	7/18	9/13	165	35.12	3 4	7.7
My Maryland	7/18	9/13	136	34.8	4.0	7.5
Coreless	7/18	9/13	65	22.12	5.6	4.9
Greater Baltimore	7/12	9/13	114	32.4	4.5	7.0
Prosperity	7/6	8/20	67	16.12	4.0	3.6
Enormous	7/12	9/13	32	12.2	6.0	2.6
Trophy	7/12	9/13	163	36.4	3.5	7 8
Stone	7/12	9/13	130	37.8	4.6	8.1
Hummer	7/12	9/13	220	45.12	3.3	9.7
Beauty	7/12	9/4	155	40.12	4.2	8.8
Globe	7/12	9/4	149	42.8	4.5	9.2
Bonny Best	7/12	9/13	178	46 8	4.2	10.1
Chalks Early Jewel	7/12	9/4	111	27.12	4.0	6.0
Kelly Red	7/12	9/13	240	48.0	3.2	10.4
Fields Early June	7/6	8/31	82	13.8	2 6	2.9
Comet	7/18	9/13	260	43.0	2.5	9.3
Early Freedom	7/12	9/13	209	31.8	2.4	6.8
LATE PLANTED.						
Matchless	7/20	9/13	117	36.12	5.0	7 9
Stone	7/20	9/13	101	31.12	5.0	6.9
Bonny Best	7/20	9/13	148	42.0	4.5	9.1

TABLE VII. COMPARISON OF THE VARIETIES OF TOMATOES TESTED IN 1913. SIZE OF PLOTS 100 SQ. FT.

VARIETIES	Date of First Picking	Date of Last Picking	Number of Fruits	Yield Per Plot Lbs. Oz.	Average Weight Oz.	Yield Per Acre Tons
EARLY PLANTED						
Chalks Early Jewel	7/7	8/28	95	23.12	4.0	5.1
My Maryland	7/7	8/28	117	30.4	4.1	6.5
Red Rock	7/7	8/28	166	38.12	3.8	8.4
New Stone	7/7	8/28	282	52.8	3.0	11.4
Matchless	7/7	8/28	175	46.12	4.2	10.1
Stone	7/7	8/28	216	46.8	3.4	10.1
Paragon	7/7	8/28	270	50.8	3.0	10.9
Blight-Proof	7/7	8/28	161	39.12	3.9	8.6
Kelly Red	7/12	8/28	200	50.8	4.0	10.9
Brimmer	7/7	8/28	77	33.12	5.8	7.3
Bonny Best	7/7	8/28	161	34.8	3.4	7.5
Bolg. New Stone	7/7	8/28	243	54.4	3.5	11.7
Greater Baltimore	7/7	8/28	212	48.12	3.8	10.6
Mills Bountiful	7/7	8/28	232	52.12	3.5	11.3
Acme	7/7	8/28	185	35.4	3.0	7.6
Langdons Earliana	7/1	8/28	128	25.4	3.1	5.4
Sunny Brook Earliana	7/1	8/28	129	28.4	3.5	6.1
Sparks Earliana	7/1	8/28	145	28.	3.1	6.0
Earliest of All	7/1	8/28	116	22.	3.1	4.7
Top Notch	7/1	8/28	207	31.4	2.4	6.7
Roth Kapchen	7/1	8/28	180	26.12	2.1	6.7
LATE PLANTED						
Paragon	8/2	9/23	129	28.12	3.5	6.2
My Maryland	8/8	9/23	83	22.4	4.3	4.8
Blight-Proof	8/8	9/23	98	20.8	3.3	4.4
Kelly Red	8/8	9/23	94	24.2	4.0	5.4
Matchless	8/5	9/23	119	30.2	4.1	6.5
Stone	8/5	9/23	117	24.12	3.3	5.4
Greater Baltimore	8/2	9/23	140	40.8	4.6	8.8

TABLE VIII. DIFFERENCE IN YIELD BETWEEN EARLY AND LATE PLANTING PER ACRE.

VARIETIES	1906 Tons	1907 Tons	1908 Tons	1909 Tons	1910 Tons	1912 Tons	1913 Tons	Aver. 7 Years Tons
EARLY PLANTED								
Paragon	......	9.3	15.0	5.6	......	......	10.9	....
My Maryland	......	......	......	......	4.5	......	6.5	....
Blight Proof	......	......	......	......	......	......	8.6	....
Kelly Red	......	......	......	......	......	......	10.9	....
Matchless	10.7	10.9	12.6	.....	10.5	4.5	10.1	....
Stone	17.6	10.2	......	9.7	14.2	8.1	10.1	....
Greater Baltimore	......	12.1	12.4	13.3	......	......	10.6	....
Five Million Dollar	12.9	7.7	12.9	10.4	......	......	......	....
Total	41.2	50.2	52.9	39.0	29.2	12.6	67.7	....
Aver. for all Varieties	13.7	10.0	13.2	9.7	9.7	6.3	9.6	10.0
LATE PLANTED								
My Maryland	......	......	......	......	10.4	.....	4.8	....
Blight Proof	......	......	......	......	......	......	4.4	....
Kelly Red	......	......	......	......	......	......	5.4	....
Matchless	6.5	7.9	9.6	.	11.2	7.9	6.5	....
Stone	5.3	8.0	......	14.6	8.1	6.9	5.4	....
Greater Baltimore	......	10.1	14.7	10.5	......	......	8.8	....
Paragon	......	8.3	9.4	10.3	......	......	6.2	....
Five Million Dollar	5.2	5.7	8.2	14.1	......	......	......	....
Total	17.0	40.0	41.9	59.5	29.7	14.8	41.5	....
Aver. for all Varieties	5.6	8.0	10.4	14.8	9.9	7.4	5.9	8.8

TABLE IX. COMPARATIVE YIELDS OF STANDARD VARIETIES OF TOMATOES PER ACRE. GROWN SEVERAL SEASONS.

VARIETIES	1907 Tons	1908 Tons	1909 Tons	1910 Tons	1911 Tons	1912 Tons	1913 Tons	General Average Tons
Early Planted								
Chalks Early Jewel	......	11.0	21.4	......	3.5	6.0	5.1	9.4
Bonny Best	......	12.9	15.8	......	4.0	10.1	7.5	10.0
Matchless	10.9	......	......	10.5	2.9	4.5	10.1	7.7
Stone	10.2	......	......	14.2	2.7	8.1	10.1	9.0
Paragon	9.3	......	......	13.7	1.8	7.7	10.9	8.7
Greater Baltimore	12 1	......	13.3	......	2.9	7.0	10.6	9.1
Coreless	......	......	5.1	10.9	1.1	4.9	......	5.5
Late Planted								
Paragon	8 3	9.4	10.3	......	......	......	6.2	8.5
Matchless	7.9	9.6	9.3	......	......	......	6.5	8.3
Greater Baltimore	10.1	14.7	10.5	......	......	......	8 8	11.0
Stone	8.0	......	14.06	8.1	......	......	5.4	9.0

TABLE X. COMPARISON OF ANNUAL YIELDS OF TOMATOES PER ACRE.

VARIETIES	1907 Tons	1908 Tons	1909 Tons	1910 Tons	1911 Tons	1912 Tons	1913 Tons
EARLY PLANTED							
Chalks Early Jewel...	10.1	11.0	21.4	......	3.5	6.0	5.1
Red Rock	10.7	......	23.7	6.9	......	......	8.4
Five Million Dollars ..	7.7	12.9	10.4	......	......	......	......
Matchless	10.9	12.6	......	10.5	2.9	4.5	10.1
Stone.................	10.2	.....	9.7	14.2	2.7	8.1	10.1
Paragon..............	9.3	......	5.6	13.7	1.8	7.7	10.9
Greater Baltimore	12.1	12.4	13.3	......	2.9	7.0	10.6
Beauty	8.7	9.3	13.0	.....	3.3	8.8	......
Hummer	......	10.9	7.5	15.4	2.5	9.7	......
Bonny Best...........	......	12.9	15.8	......	4.0	10.1	7.5
Coreless	......	11.1	5.1	10.9	1.1	4.9	......
My Maryland	......	.....	......	4.5	2.2	7.5	6.5
Kelly Red............	......	.....	......	......	1.9	10.4	10.9
Gordoniers Earliana...	......	.....	20.6	9.2	......	......	......
Sparks Earliana.......	......	.....	23.4	9.6	4.4	......	6.0
Langdons Earliana....	......	......	......	......	2.8	......	5.4
Sunnybrook Earliana.	.....	......	......	.....	......	......	6.1
LATE PLANTED							
Matchless	7.9	9.6	9.3	11.2	......	7.9	6.5
Stone.................	8.0	......	14.6	8.1	......	6.9	5.4
Greater Baltimore	10.1	14.7	10.5	......	......	......	8.8
Paragon	8.3	9.4	10.3	......	......	......	6.2
My Maryland	......	......	......	10.4	......	......	4.8

TABLE XI. SHOWS THE AMOUNT OF RAINFALL IN INCHES FOR THE SEASONS DURING THE PROGRESS OF EXPERIMENT.

	1906	1907	1908	1909	1910	1911	1912	1913
April.....................	3.44	2.25	1.90	2.56	6.31	3.06	3.28	5.95
May......................	1.73	3.44	4.27	2.91	3.94	.73	7.10	4.82
June.....................	7.56	5 58	1.41	4.75	4.42	3.07	6.28	1.92
July......................	6.81	2.84	1.42	1.89	1.62	.90	5.16	1 44
August...................	9.34	2.84	5.32	2.10	1.59	7.38	1.35	5.92
September	.50	8.06	5.14	......	.92	1.95	4.53	2.23
October..................	2.01	2.02	1.76	......	4.23	4.98	.75	3.11

Discussion of Results.

A study of the tables shows that there is a great variation both between the varieties any one season and also different seasons. It will also be noticed that the rainfall varied considerably. Too much or too little rain of course affects the yields. Long spells of hot rainy weather interferes very much with the setting of the fruit. And very dry weather also restricts the growth and retards the development.

Of the varieties tested, Greater Baltimore has been the most persistent in high yield. Bonny Best also yielded well and is deserving of a trial either for market or canning. Coreless was generally low in yield. It is late coming into bearing and is possibly very much affected by the hot dry weather.

Sparks Earliana was the first of the Earliana type to be introduced. Since its introduction several growers and seedsmen have made selections that were said to be improvements on the original. Some of these selections have been tested here from time to time. The observations and records do not seem to have shown that any one is better than the other. In fact the Sparks Earliana has been generally the best in yield.

Such selection work, however, should be encouraged as it tends to keep the variety up to the standard.

Good Varieties.

Of the varieties tested, Sparks Earliana, Chalks Early Jewel, and Bonny Best can be recommended for early or short season varieties. For late season and canning, Greater Baltimore, Stone, Kelly Red, Red Rock, Matchless are good. These are all red varieties. If the pink varieties are wanted, June Pink and Acme are good for early, with Beauty and Globe for late.

If very large solid tomatoes are desired, without regard to regularity in shape, Ponderosa and Crimson Cushion are very good.

TOMATO DISEASES.

By J. B. S. Norton.

In addition to unhealthy conditions resulting from soil, climate and improper management, discussed in the other sections of this bulletin, the following tomato diseases resulting from the attacks of fungous and bacterial parasites need consideration.

Each of the diseases is discussed separately, but it is well to remember that several may be present on a plant at the same time. The yellowish leaves caused by fusarium in the stem may be covered with the small spots of the septoria leaf blight.

Plant Bed Troubles.

Just as all other effort to get the best seed grown under the best conditions is the key to success, so attention to disease in the plant bed will give results out of all proportion to the expense.

Some diseases do their greatest damage to the young plants. Not only this, but some of the worst field diseases such as the wilts, may be disseminated from infected beds to previously healthy parts of the farm or often to many farms. Be careful where your plants come from.

The practice of growing young plants on the same ground year after year is particularly unwise from the standpoint of spreading disease.

If the young plants are crowded or in damp dark conditions, various fungi, which thrive under such circumstances, attack the young stems at the ground and kill them. This is commonly called *damping off*. It may be checked by giving the plants more sunshine and keeping the surface soil close to them dry and well worked up.

Spraying the plants in the bed with Bordeaux mixture is an excellent practice and inexpensive compared with field spraying. It not only prevents early fungous attack, but keeps off flea beetles which do great damage, especially to young plants, and besides infect the plants with fungous and bacterial diseases. A very simple matter and also a good protection to the plants when in a weakened condition, is to dip the tops in Bordeaux mixture when transplanting to the field.

Fusarium Wilt.

There are two serious wilt diseases of tomatoes in Maryland. One due to a fungus attacking the stem and roots, the other caused by bacteria of similar habit. The average observer would not confuse these diseases with the ordinary wilting due to lack of water in the soil, excessively hot dry air or an injured root system.

The most common wilt is caused by a mold-like fungus (probably all *Fusarium lycopersici Sacc.*, though the potato wilt fungus, *Fusarium oxysporum* (Schlect.) Wollenw., sometimes occurs on tomato) growing in the minute water-conducting vessels of the woody part of the tomato stem and root. The affected plants gradually sicken, usually after they have begun to blossom and fruit. The plants have a generally unhealthy appearance, the lower leaves turn yellow and the whole plant finally withers up and dies. The woody part of the stem inside the yet green bark is brown or black and the roots or some of them are dead.

Isolated plants here and there show the disease first, the rest of the field seeming healthy, but one after another may succumb until nearly all the plants in an infected field may die long before the end of the season.

This disease is now common in the tomato growing sections of the State, though there are many farms not yet infected.

Since this fungus may live over in the soil for several years, once it has appeared in a field, it is important to prevent its spread as much as possible. One should not get plants or seed from a wilt infected farm, and care should be taken not to put material from an infected field upon a clean one, though infection from carrying the fungus on tools or feet would be rather difficult to prevent. The infection may also be washed to lower land from diseased fields lying higher.

Spraying would not be expected to have any value for such a disease, and our tests with sprays in 1911 did not affect it.

The growing of resistant varieties is the best hope for relief in fields already infected with the fusarium wilt. A rotation plan leaving the land free from tomatoes for four or five years, together with good soil conditions to prevent drouth injury, will also eliminate most of the loss from this disease.

INVESTIGATIONS ON WILT RESISTANCE.

The varieties in the following list were planted early in June, 1912, on soil badly infected with fusarium wilt disease in 1910, near Preston, Md. In the first column of figures is given the precentage of plants wilting or dead August 20th. The next gives percentage of plants dead September 28th. The last column gives the number of plants set in June. Many, no doubt, died of other causes than wilt. In many cases all the leaves were dead on September 28 from septoria, but unless attacked by wilt the stems were usually yet green.

TABLE 1.

RELATION OF TOMATO VARIETIES TO FUSARIUM WILT IN 1912.

	Per Cent. Wilt Aug. 20	Per Cent. Dead Sept. 28.	Number Planted.
Florida Special........	44	81	85
Duke of York........	2	18	88
Greater Baltimore......	43	86	85
Faultless	1	5	87
Improved Ponderosa...	20	71	88
Native Mexican........	33	93	30
Tennessee, 8*.........	13	58	29
" 13..........	0	48	29
" 16..........	14	33	27
" (general)....	7	34	86
" 9..........	13	27	58
Diadem	33	72	57
Dwarf Giant..........	0	60	60
Golden Queen.........	0	9	55
Sunrise	14	73	83
Comet	0	1	87

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*These five "Tennessee" numbers were from wilt resistant selections made at the Tennesee Experiment Station. As reported in Bulletin 95, Tennessee Experiment Station, Essery has obtained almost immune strains from tomatoes of "Beauty" type. A strain of Acme resistant to fusarium is reported in Bulletin 142, Louisiana Experiment Station.

Red Pear	0	70	53
Terra Cotta	0	0	90
Yellow Peach	0	0	89
Red Plum	2	41	58
Jewell	55	84	87
Hummer	15	43	87
Stone	19	21	88
Dwarf Champion	0	27	45
Acme	19	36	55
Dwarf Stone	0	4	49
Beauty	9	24	58
Dwarf Aristocrat	15	45	84
Globe	4	10	75
Gold Ball	0	2	40
Buckeye State	1	5	87
Coreless	32	43	88
Dwarf Purple	0	47	48
Favorite	31	65	52
Magnus	30	70	59
Paragon	30	64	56

It will be seen that many of the wilt resistant varieties are small fruited ones of no commercial value. Several resistant kinds, Buckeye State, etc., are of the purple fruited type, a kind not generally planted for canning.* The dwarf varieties were generally resistant.

Several of the more resistant varieties of the 1912 test were crossed in the greenhouse during the winter of 1912-13 by Mr. White, in the hope of securing hybrids with the resistant character combined with a good canning type of fruit. None of the plants resulting from these crosses showed any marked resistance when planted out in the summer of 1913 on wilt infected land, but it is yet possible that the second generation may bring out the desired combinations.

A more promising method of securing wilt resistant strains seems to be in selecting seed from plants remaining alive and more or less healthy late in the season, where most of the surrounding plants had died of the disease. A large number of such selections were made from wilt infected fields in various parts of Eastern Maryland in September, 1912. Plants grown from these were set on wilt soil in the summer of 1913. Table II is a diagram of the plot and will show the results and the relative position of the plants in the field. The numbers designate the different selections, each representing seed from a single plant, and the rows running from the number toward the right. A great many plants were lost due to unfavorable weather and soil conditions in the seed bed and at time of planting. Each oval or dot represents a plant. O indicates no evidence of wilt infection, o indicates plant partly affected, o badly diseased; . signifies plant dead from wilt disease. The missing plants are represented by blank spaces.

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*A fact not generally known among growers and canners is that the red or scarlet fruit color is due to the yellow skin of the fruit in such varieties, the fruit of the purple or pink varieties having a transparent colorless skin, while the flesh of both is of the same purplish color, though some varieties without regard to the outer color may have redder flesh than others. As the skin is removed in canning the outer color alone need not be considered.

TABLE II.

RESULTS OF SELECTIONS AND CROSSES ON WILT INFECTED SOIL IN 1913.

1 o	.	.		O	o	.	2		O						O		O	O	
3 .	o	o	O	o	.		.	.	.		4 o	o			O	O			O
5 o	o	.			o	o			.	O	O	6 .		.					o
7 o			o	o	o	8.	9.	10	.	.	11 o	.	.	o	o	.	.	.	o
12.	.	o	o	.	o	.		13 O	O	O	O		O			14 O	o	o	.
15		O	O	O	O	o		O	16 O	o	O	17 o			18.	o	o	o	.
19 O		o	O	O	o		O	O	o		o	O		O		O	O	O	
20 O	O	O	21 .	o	.			.	22	.		o	o	.	O	.	.	.	.
23.	O	O	24 o	.	.	.	o	.		.	o	.	25.	o	o	.	o		o
26 O	27 o		.	.	.	.	o	.	.		.	.	o	28 O	o		o	o	.
29 O	o	.	o	.	o	O	.		.	o	o	30 o		o	o	31 O	O		o
32.	31 O	O	o	o	.	.	o	.	.	o	o	o		O	O		o	o	o
32 o	o	.	.	.	.	.	.	.	.		.	.	.	.	33 o	o	O	o	o
33 o	O	o	o	.	o	.	.	o	o	.	.	.	O	o	o	o	o	o	o
33.	.	o	o	.	.	o	.	.	o	.	.	o	O	O	o	o	O	.	o
33 O	34 .	o	.	.	.	o	.	o	o	o	.	o	O	o	o	o	o		o
35 O	.	o	o	.	.	.	.	36 .	.	.	.	34 o	o	o	o	o	O	o	o
35 o	o	o	o	.	o	.	.	o	.	.	o	o	.	o	O	o	o	o	o

The numbers in Table III designated as "Canning type, variety unknown," are selections from fields of the ordinary canning varieties, in most cases mixtures, chiefly of Stone, Greater Baltimore, Red Rock, etc. The selections from Stone, Greater Baltimore, Coreless, Dwarf Stone and Paragon are mostly from the better plants in the 1912 field at Preston, represented in Table I. While there were not enough individuals of many of the selections to make them of much value, it will be seen that practically all the selections from Stone and Greater Baltimore are badly affected by wilt, while those from Coreless and Paragon were quite resistant. All the five plants of No. 13 were entirely free from wilt and were a fine type of tomato in size, color, vigor and yield.

TABLE III

Percent of wilt disease in the numbered selections, crosses and varieties of Table II. Counting (.) as 1, (o) as ½, o as ¼, O, as 0.

No. as given in Table II	NAME	No. Plants grown	% of Wilt
1	Canning type, variety unknown................	6	58
2	“ “ “ “	4	0
3	“ “ “ “	9	75
4	“ “ “ “	5	10
5	Source unknown................................	8	41
6	White fruited sport of Stone, not selected for resistance..................................	3	75
7	Canning type variety unknown.............	4	38
8	Selection from Stone..........................	1	100
9	“ “ Greater Baltimore.............	1	100
10	Canning type, variety unknown................	2	100
11	“ “ “ “	9	72
12	“ “ “ “	7	75
13	“ “ “ “	5	0
14	“ “ “ “	4	44
15	Selection from Coreless.................... ..	6	4
16	“ “ Dwarf Stone..................	3	17
17	“ “ Coreless......................	1	50
18	Canning type, variety unknown................	5	60
19	Selection from Coreless.......................	14	7
20	“ “ Paragon........................	3	0
21	“ “ Greater Baltimore...............	4	81
22	“ “ Stone..........................	9	69
23	“ “ Paragon.................	3	33
24	Canning type, variety unknown................	9	83
25	Selection from Stone..........................	6	54
26	Canning type, variety unknown................	1	0
27	Selection from Stone..........................	11	82
28	“ “ “	5	40
29	“ “ “	11	54
30	Canning type, variety unknown................	3	25
31	Tennessee, No. 8 x Dwarf Aristocrat...........	20	35
32	Comet x Red Pear............	15	98
33	Tennessee, No. 13 x Comet & Dwarf Aristocrat	45	55
34	Buckeye State x Dwarf Aristocrat.............	26	50
35	Buckeye State x Texas Belle..................	28	58
36	Selection from Stone..........................	4	100

Another year's test on wilt infected land in different localities will be necessary to show just which of the various kinds, that have shown apparent wilt resistance in the two years' test, will be best fitted for growing on wilt infected fields in Maryland, as some of the freedom from wilt may have been due to absence of the fungus from some parts of the infected field. There is also a possibility that there are also different strains of the wilt fungus in different localities and that different soil conditions will affect the devolopment of the disease. But the results are very promising for the control of this disease by growing varieties of quality and yield suited for canning and which are not unfavorably affected by the fusarium fungus. Steps are being taken now to increase the supply of seed of the more desirable kinds by growing another generation in the greenhouse. It is hoped that these will be ready to produce plants in time for the 1914 crop. If so, a number of tomato growers, who wish to test them on land badly affected with the wilt last year, can be supplied with enough seed to grow a row in comparison with the ordinary varieties.

Tomato growers now troubled with this disease should select seed from the best plants on the worst wilted fields, as these are more apt to belong to wilt resistant strains of the variety grown. It is very important to grow the plants from each parent plant separately, so one can tell which are the better strains to breed from, as some of the selections are sure to be from plants which simply escaped the disease and are no more resistant than others.

BACTERIAL WILT.

The other tomato wilt disease, bacterial wilt or southern blight, is caused by bacteria (*Bacillus solanaceanum* E. F. Smith) growing in countless numbers in the woody part of the tomato stem between the pith and bark. It is wide-spread in the South and occurs in many places in Maryland. It affects also potatoes, tobacco and related plants. It is usually first seen after the plants are of good size and well established. The leaves wilt usually at the tips first, the woody part of the stem turns brown or even black, the plant stops growing and soon dies. If an infected stem is cut across, the masses of bacteria may exude as milky drops on the cut surface.

Insects carry the disease from plant to plant, but spraying against them has proved of little or no benefit. As the bacteria live over in the soil of infected fields for several years, stopping the culture of tomato, potato and related plants on infected land, it is necessary to prevent its further increase, and to allow the germs in the soil to gradually die out.

Another bacterial stem disease of tomato caused by *Pseudomonas michiganensis* (E. F. Smith) Stev., has been described by Dr. Erwin F. Smith. It has not been reported from Maryland.

LEAF BLIGHT.

Leaf blight or leaf spot is the most common and destructive disease of the tomato in Maryland, though not so troublesome in states north of this or in the South. It is usually noticed first in July as round or angular dark spots at first on the lower leaves. These spots are from the size of a pinhead up to an eighth of an inch and if abundant may affect so much of the leaf surface that it soon shrivels and dies.

In the gray center of the spots several small black dots can usually be seen. These are the fruiting organs of the fungus, *Septoria lycopersici* Speg., which is causing the disease. Each of these dots contains a large number of minute toothpick-shaped spores, each of which if placed on a tomato leaf under proper conditions for growth, may in warm weather produce another disease spot in 5 to 10 days. In this way the disease spreads rapidly from the lower leaves until all but the young leaves at the tips of the branches may be killed and the growth of the fruit stopped and proper ripening interfered with. This is especially true on land and in seasons where conditions for vigorous growth of the tomato are lacking. If the water supply in the soil fails seriously, all the leaves and even some of the stems may be killed by the disease and only the bare stems and sunburned fruit left. The disease may also attack the fruit, causing dark spots. The spores on the stem spots are much shorter than those on the leaf, but otherwise similar.

If the tomatoes can be kept growing by good water-retaining soil and proper fertilizer they may not be seriously injured though all the lower leaves are killed by the disease, as is usually is the case nearly every year in Maryland.

Spraying frequently with Bordeaux mixture will reduce the loss, but judging from many experiments made in Maryland and in other states one should not expect more than 10 to 20 percent increase in yield unless spraying is begun early and kept up throughout the season. At least five sprayings at two or three-week intervals, beginning in the bed, would need to be made, and the field planted so that a sprayer could be run through it after the plants are full grown. Spraying could be done more rapidly with a field sprayer and so could be done oftener with less expense than where the nozzles were handled by men, though with the latter method the work could be much more effectively done.

The cost of spraying tomatoes has not been determined for Maryland, but each spraying would probably run about $1.00 per acre or less.

The following table gives the percent increase in yield from spraying tomatoes in most of the experiments which have been made in various states, except cases when the published results did not give the yield. The figures are taken from the bulletins and reports of the Experiment Stations in the states named.

TABLE IV.
PERCENT INCREASE IN YIELD OF FRUIT ON SPRAYED TOMATOES.

State	Year	No. of vars.	Times Sprayed	When sprayed	% increase	Variation of % increase on different varieties.
Md.	1896	35	4	June 6 to July 28....	36	5 to 137
"	1897	19	3	July 14 to Aug. 6....	27	3 to 70
"	1896–97	14	3–4	" "		8 to 97
"	1896–97	Stone	3–4	" . "	52	
"	1898	"	3	in bed and 2 later....	90	
"	1899	"	?		35 less	
"	1913	"	5	throughout season ..	12	
N. J.	1896	?	4	June 13, 25, July 7, 21	24	
"	"	?	1	in seed bed..........	41 less	
"	"	?	2	July 7, 21...........	44 less	
"	1900	2	9	June 11 to Sept. 24..	23	20 to 32
"	"	2	9	" " " " "	7	4% less to 20%
Del.	1898	?	3	June 6, July 9, 18....	4	
"	"	?	6	June 6, July 9, 16, 22, Aug. 5, 16.........	25	
"	"	?	2	July 9, 16...........	15	
"	"	?	5	July 9, 16, 22 Aug 5, 15	7	
"	"	?	2	July 22, Aug. 5......	22	
"	1899	?	7	May 12 to Aug. 2....	37	
"	"	?	5	June 16, to Aug. 2...	18	
"	"	?	2	July 17, Aug. 2......	34	
"	1902	?	2	July 14, Aug. 14.....	12	Variation in different years
Ill.	1905–09	?	5–6	May to end shipping season............	64	38 to 148
"	1905–09	?	every 4 wks.	May to end shipping season............	42	26 to 109
"	1905–09	?	every 2 wks.	Till staked...........	13	9 to 52
"	1905–09	?	every 2 wks.	After badly infected.	17	2% less to 82%

Perhaps the principal thing the above table shows is that it is not wise to draw conclusions from a few experiments. It will be seen, however, that in general there is considerable benefit from spraying. This varies greatly with different varieties, and in different years, influenced, of course, by the amount of blight. When there is but little blight little increase shows from spraying, and in years when blight is very bad it may take more spraying to overcome it. The second line for N. J., 1900, was on new ground and shows the difference as compared with the line above which was on land infected with blight from previous crops of tomatoes. The great variation in the experiments in Maryland, 1896 to 1899, and in Delaware, 1898, is no doubt due largely to the plots of each variety being quite small. The Illinois experiments demonstrated that spraying is of no value for early market tomatoes, in fact, blight may ripen them a little earlier.

Practically all the varieties grown in America and Europe have been tried here the past two years, and all showed about the same amount of septoria blight on the foliage. Some varieties are, however, more vigorous growers, and continually keep ahead of the blight by the production of new foliage. The early varieties are usually less vigorous and show more blight injury.

From the above as well as many other experiments and demonstrations it appears that spraying every two or three weeks from the plant bed on, at least to picking time, say 5 to 7 applications, would in years when the blight and flea beetle are as common as usual, yield a profitable increase. The cost would vary greatly in different places, but one ton increase per acre ought to pay the cost of spraying under ordinary conditions. 17 percent is the average of all the averages of increase given in Table IV; 28 percent the average of all when more than 3 sprayings were given. The average of 4 years spraying of Stone at our Experiment Station is 24 percent increase. A series of experiments with the best commercial varieties on good sized fields determining cost and yield for a sufficient number of years to eliminate the difference due to variation in the amount of blight and price of tomatoes in different years is needed to prove the exact income to be expected from spraying for a series of years.

Other fungi, such as *Alternaria solani* (Ell. & Mart.) Jones and Grout, sometimes cause leaf spots on tomatoes, but none except the septoria does much damage in Maryland.

Leaf Mold and Other Greenhouse Diseases.

This disease is caused by the growth of the fungus *Cladosporium fulvum* Cke. on the under side of leaves. It rarely causes trouble in Maryland fields, but is one of the worst enemies of the greenhouse tomato. The grayish brown patches of the fungus spread rapidly, the surface of the leaf above them discolors, and the whole leaf soon curls up and dies. The disease is encouraged by warm, moist conditions. Ventilating so as to keep the air moderately dry is the best treatment. Sraying with Bordeaux mixture has been recommended, but once the disease is well started spraying will not keep it under control. There is said to be considerable benefit from sulfur fumigation, such as is practised for rose mildew by putting sulfur on the heating pipes or using a sulfur evaporating devise (see Bulletin 156). There is too much danger of injury from burned sulfur, even in very small amounts, to consider its use except in empty houses.

In greenhouses tomato diseases may generally be kept in control by modifying the conditions of heat, moisture, air, etc., which favor their development. As this bulletin considers chiefly the field-grown tomatoes, the greenhouse conditions for tomato health will not be further discussed. Those especially interested in diseases of greenhouse tomatoes are referred to Bulletin 138, Massachusetts Experiment Station.

Mosaic Disease.

This appears as lighter green blotches in the normal green color of the leaves. In severe cases the leaflets are distorted and narrow, with long points or even no wider than their stems. It affects tobacco and some other plants of the same family and similar diseases are found on many other plants. The yellows of peaches is like it in many respects. Although the disease is known to be infectious, the cause is not known, and very little has been worked out on the amount of damage it does or on its control, at least, on the tomato, though the disease in tobacco had had considerable work done on it (see Allard, Bulletin 40, United States Department of Agriculture, 1913). The infection takes place on the younger parts of the plant. The diseased parts of the plant may retain their power of infecting others for many months after they are dead and dry.

This disease has been noticed extensively in Maryland only for the last two or three years. It is now generally distributed in both field and greenhouse. It appears first on scattering plants in the field and later spreads until by frost practically all the plants may be affected, but, although no careful measurements of healthy and diseased plants have been made, it does not seem to greatly reduce the yield of fruit. In the greenhouse the diseased plants average 3 to 30 percent lower in height than the healthy ones, according to the length of time since infection, have fewer flowers and about 30 percent less fruit set.

Downy Mildew.

This disease, which is the same as the late blight of potato, which is so destructive to potatoes in the North, has caused loss to tomato growers in California, Virginia and other States. It has not been reported from Maryland on tomato, and the high summer temperatures of the tomato growing section of this State are not favorable to the fungus. But it may appear in the higher parts of the western counties.

The disease is caused by the fungus, *Phytophthora infestans* (Mont.) De By. It appears suddenly in warm moist weather as dark spots on all green parts, these spread rapidly until the plant may appear as if frosted. A severe rot of the fruit may result.

Spraying frequently with Bordeaux mixture is the treatment recommended.

Blossom-End Rot.

Blossom-end rot or point-rot is a somewhat dry black rot appearing at the blossom end of the ripening or still green fruit. It is more common on early fruit and on dry soil, but is favored by any condition causing extremes of wet and dry.

The best preventive is increasing the water holding capacity of the soil by organic matter and surface tillage, or when possible to supply the plants with water during drouth.

Anthracnose.

This is another common rot especially of the ripe fruit. It appears as round sunken decayed spots on the fruit, similar to those of bitter rot of apple, though not so dark. The spots may quickly spread and produce a general decay of the fruit. Spraying with Bordeaux mixture will help to keep it under control, as will keeping the affected fruits picked and removed from the field.

The disease is caused by the fungus, *Colletotrichum phomoides* (Sacc.) Chest., which is perhaps a form of the bitter rot fungus, *Glomerella rufomaculans* (Berk.) S. & S.

Shedding Blossoms.

Several things may prevent fruit from setting. Too much nitrogen gives a greater tendency to foliage formation and less to fruit; rainy or moist weather or even dark cloudy days prevent pollination; hot dry weather or anything else that reduces the amount of water in the plant may cause the blossoms to drop.

Fruit Cracking.

Weather conditions that check the growth of the fruit, followed by favorable conditions for growth, may cause cracking of the fruit. Some varieties are more subject to it than others.

Sunburn.

Yellow-blotched or scalded fruit may result from hot weather. This trouble is often bad on plants defoliated by the septoria blight, leaving the fruit on the ground exposed to the full heat of the sun. Sun injury was found to be worse on unstaked tomatoes in Illinois, (Bulletin 144, Illinois Experiment Station). Duggar has shown that the formation of red color in tomatoes is suppressed or retarded at temperatures above 86° F.*

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*Other diseases doing slight damage to tomatoes in Maryland are: Edema, in which warm soil, excess of water, lack of light, etc., cause curving of leaves, swollen leaf tissue and irregular growth in greenhouses; *Alternaria fasciculata* (C. & E.) Jones & Grout, is associated with the blossom-end rot and causes a decay of the ripened fruit.

Tomato diseases not yet reported from Maryland are: *Rosette*, with dwarfed curled leaves and stem rot caused by *Rhizoctonia*. *Southern blight*, similar to the bacterial wilt, but caused by *Sclerotium Rolfsii* Sacc. Olive black growth of mold on leaves due to *Fumago vagans* Pers. *Mildew* caused by *Erysiphe polygoni* D. C. Fruit rots caused by *Bacterium briosianum* Pav., *Pseudomonas fluorescens* (Flugge) Miq., *Bacillus cartovorus* Jones, *Bacillus lycopersici* Hegyi, *Phytobacter lycopersicum* Groenew., *Fusarium sclerotium* Wollenw. and *Fusarium falcatum* App. & Wollenw. The crown gall germ *Pseudomonas tumefaciens* (S. & T.) Stev., has been found on tomato, also diseases due to *Vermicularia varians* Duc, *Cladosporium scabies* Cke. *Dendrodochium lycopersici* March, and *Aschochita hortorum*. Various physiological diseases, some peculiar to the tomato and others common to other plants occur, but are not important or well known enough to be discussed here.

General Treatment.

The best means of controlling most tomato diseases is to keep all plants in strong, active, growing conditions. Only vigorous, stocky plants from the best parents should be set out, and so far as possible, they should not be checked at any time in their growth. One of the principal points in growing perfect tomato plants is to *keep* them growing. If the roots are injured much in transplanting, the plants lose vitality and are then more susceptible to the entrance of parasites, as well as to injury by unfavorable weather conditions.

The plants should be well cultivated and cared for on good, well-drained loam and rotation (not with potatoes or tobacco) practiced from year to year. Plenty of vegetable matter in the soil and frequent cultivations to retain moisture is necessary. Water is the best tonic.

Spraying with Bordeaux mixture is important, especially on the young plants, and is generally profitable if kept up at frequent intervals throughout the season. The 4-4-50 formula with addition of ¼-pound of Paris green or 2 pounds of arsenate of lead is recommended, especially when Colorado potato beetle or tobacco worm is present. Full details regarding Bordeaux mixture and other information on spraying can be found in Bulletins 143 and 164 of this Experiment Station.

TOMATO CULTURE.

By John F. Monroe.

The cultural part of this bulletin is being written, not with the expectation that all who read it will increase their yield to 8 or 10 tons per acre if it is followed, but rather that most of them will get some idea of how to better grow the crop. This will result in more general and more profitable production of one of Maryland's most important crops.

Exclusive of Delaware, Maryland packs more tomatoes than all the rest of the United States. Of the total pack of 1913 of 14,206,000 cases, of 24 cans each, Maryland packed 44.20 per cent, or 6,280,000 cases. It required about 10,000,000 bushels of raw fruit to produce last year's pack. Part of the tomatoes packed in Maryland were imported from other States, yet our growers received approximately two and one quarter million dollars from the canneries for their crop.

McCue* estimates the average cost of producing an acre of tomatoes, from rent of land to delivery at factory, to be $38.61 in Delaware. This is a very fair average cost of production under

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*Delaware Bulletin No. 101.

Maryland conditions, which are similar to those existing in Delaware. In reply to a number of letters sent to growers, regarding the cost of production, the average amount was $36.33. One grower, whose haul to the factory is about two miles, estimated the cost at $45.00 an acre. However, his gross returns were $132.00 an acre, leaving a net return of $87.00. This grower's work is given to show the possibility of the tomato crop.

Estimating the average yield of canning tomatoes at four and one-half tons per acre, and the average price at $9.00 per ton the past year for Maryland, it will be seen that the growers are making $1.89 per acre on the estimated cost of $38.61. This means that it is not very profitable as a money crop. If four and one-half tons per acre is the average yield, many growers who get less than this are losing money on their tomato crops. On the other hand, some growers who are practicing modern methods of farming, are making money on this crop.

Tomato Soils.

The tomato grows well in nearly all types of soils found in Maryland. The prevailing opinion among successful growers is that soil condition rather than soil type is important in tomato growing.

The tomato plant cannot grow well with "wet feet" for any length of time. The soil must be drained, either naturally or artificially, to get rid of free water. There are many soils where a thorough system of tilling would be found profitable, not only in this crop, but in the permanent development of our agriculture. Removing free water permits of better aeration of the soil, thereby bettering conditions for releasing the plant food which is stored in the soil. This tends to reduce the cultivation necessary to get the soil in good physical condition.

Decayed vegetable matter (humus) makes the lighter soils more retentive of moisture, and the heavier soils more open and friable. Humus is generally supplied to most Maryland soils by growing green manure crops; however, in some sections, if the farmers would raise more live stock, they would help to solve this problem by having more farmyard manure to use on the land.

The Place of Cover Crops in Tomato Growing.

Cover crops are often called catch crops or green manure crops. The name used makes no difference, the results are the same, and the grower is after results. These crops are grown for supplying humus. adding nitrogen, improving the general physical condition of the soil, and to prevent washing of the soil during the winter months.

Probably the easiest and quickest way of adding humus is by using farmyard manure. However, the supply of humus from this source is generally limited, owing to an insufficient supply of manure. The cover crops make it possible to obtain a plentiful supply of humus almost as readily, and growing them should be the practice of every tomato farmer in the State.

Cover crops can be divided into two general classes. I.—Nitrogen gatherers or nitrogenous crops. 2.—Non-nitrogenous crops. Leguminous plants, as crimson and other clovers, cow peas, soy beans, vetch, garden peas and beans, and alfalfa, belong to the class of nitrogenous plants. All non-leguminous plants, as rye, wheat, buckwheat, rape and other plants, belong to the second class.

Nitrogen is the most expensive element of plant food the grower has to buy; therefore, knowing that the nitrogen gathering plants supply a considerable amount of this element, it would seem that it would be economy to grow them for this purpose. They extract nitrogen from the air through the nodules on their roots. There will probably be some conditions obtained which favor the growing of some nonleguminous crop, but if possible grow a leguminous crop.

Crimson clover as a cover crop seems to work very well with tomato growing. It will generally be found more satisfactory than other green manure crops in Maryland. If local conditions favor any other cover crop, grow it. This brings up the necessity of tomato growers studying the various cover crops before deciding definitely.

Having decided on the cover crop to grow, the time of plowing it under is important. In the first place, never cut any of the crop for hay. It is grown to improve the soil, not for feed. The hard stubble plowed under will in many cases not permit of thorough firming and settling of the soil. This layer of hard woody fibre between the top and underneath soil will lessen the upward flow of water in the soil. As a result, the crop will suffer from lack of moisture, especially in dry weather. This or the plowing under of the cover crop too late in the season is frequently the cause of poor results from the use of crimson clover or other green manure crops. On the other hand, if the crop is plowed under early while still soft and green it will rot down quickly and help to hold moisture and result beneficially to the tomato crop.

Tomatoes and Crop Rotation.

The tomato, as grown in Maryland for canning, is more of a farm crop than a special truck crop. Therefore, it must be properly placed in the rotation of general farm crops. If potatoes are grown on the same farm, they should be placed as far as possible from the tomatoes in the rotation.

Number and Length of Rotation	1st Year	2nd Year	3rd Year	4th Year	5th Year
No. 1 3 Years	*Tomatoes* *Cowpea Hay* Wheat	*Wheat* Cr. Clover	Cr. Clover *Corn* Cr. Clover or Rye.	Cr. Clover or Rye. *Cowpea Hay* *Tomatoes* Wheat	
No. 2 4 Years	*Tomatoes* *Cowpea Hay* Wheat	*Wheat* Mixed Clovers and Timothy	*Clover and* *Timothy Hay* Fall Pasture	Sod Land *Corn* Cr. Clover	Cr. Clover *Cowpea Hay* *Tomatoes*
No. 3 5 Years	*Tomatoes* *Cowpea Hay* Wheat	*Wheat* Mixed Clovers and Timothy	*Clover* and *Timothy Hay* Fall Pasture	*Pasture*	*Corn* Cr. Clover
No. 4 3 Years	*Tomatoes* *Cowpea Hay* Wheat	*Wheat* *Buckwheat* Cr. Clover	*Cr. Clover* *Hay* *Corn* Cr. Clover	Cr. Clover *Cowpea Hay* *Tomatoes* Wheat	
No. 5 5 Years	*Tomatoes* *Cowpea Hay* Wheat	*Wheat* Mixed Clovers and Timothy	*Clover and* *Timothy Hay*	*Potatoes* (Early or Late) Cr. Clover	Cr. Clover *Corn* Cr. Clover
No. 6 3 Years	*Tomatoes* Cr. Clover	Cr. Clover Plant Strawberry Bed.	Strawberries *1st Harvest* *Cowpea Hay* Cr. Clover	Cr. Clover *Tomatoes* Cr. Clover	
No. 7 4 Years	*Tomatoes* Cr. Clover	Cr. Clover Plant Strawberry Bed.	Strawberries *1st Harvest* *Cowpea Hay* Cr. Clover	Cr. Clover *Corn* Cr. Clover	Cr. Clover *Tomatoes* Cr. Clover

No. 1	This is a fairly good rotation to follow, but may be short of hay for some conditions.
No. 2	Probably the best rotation for general farm conditions in Maryland.
No. 3	Very good, especially on farms raising live stock.
No. 4	A good rotation which is being practiced by an Eastern Shore farmer.

No. 5	Good where tomatoes and potatoes are commercial crops on the same farm. Early potatoes might be followed by buckwheat or some quick growing hay crop.
No. 6	Lacking in legumes for the best results from the two chief crops of the rotation.
No. 7	Preferable to No. 6, where conditions will permit its practice. Strawberries may be cropped a second year in this.

The preceding table gives a number of different rotations in tomato growing. The crop in Italics each year is harvested that year in the rotation. Use manure, if obtainable, on the corn, strawberries or other cultivated crops rather than directly on tomatoes or potatoes. Cow peas, as a hay crop, have been included in the same year as the tomato in most rotations, because most growers grow larger acreages of corn and wheat than tomatoes. This land can be used to good advantage as suggested in cow-peas. Alternate the division of the field in growing cow peas and tomatoes. Buckwheat can follow wheat in many sections as included in Rotation No. 4. It is believed that this table will meet most conditions and types of cropping which include the tomato in Maryland. However, the grower must work this out for his own conditions. If any type of farming is met which is not included in the table, it will help somewhat in suggesting ways of arranging the rotation to be followed.

Rotation of crops helps to build up the soil in different ways. It adds humus in many cases. Crops differ in their demand on the soil regarding kinds and amounts of plant food, culture and soil conditions. This tends to maintain an equalization of conditions in the soil. Plant diseases do not gain as strong a hold on the land where rotation is practiced, as where successive crops of one kind are grown.

Growing peas for the cannery is an important crop in many parts of the State. This is an early spring crop. In most sections it is harvested in plenty of time to allow planting tomatoes. This system of cropping gives double use of the land in one season, during the rotation for growing cash crops. While it is to be recommended where practicable, it will give the best results if the farmer will give sufficient care to the tomato seedlings, to develop the best possible plant to set in the field following the removal of the peas.

Field	1914	1915	1916	1917	1918
No. 1	*Tomatoes* *Cowpea Hay* Wheat	*Wheat* Mix. Clovers and Timothy	*Clover and Timothy Hay*	*Potatoes* Cr. Clover	Cr. Clover *Corn* Cr. Clover
No. 2	*Wheat* Mix. Clovers and Timothy	*Clover and Timothy Hay*	*Potatoes* Cr. Clover	Cr. Clover *Corn* Cr. Clover	Cr. Clover *Tomatoes* *Cowpea Hay* Wheat
No. 3	*Clover and Timothy Hay*	*Potatoes* Cr. Clover	Cr. Clover *Corn* Cr. Clover	Cr. Clover *Tomatoes* *Cowpea Hay* Wheat	*Wheat* Mix. Clovers and Timothy
No. 4	*Potatoes* Cr. Clover	Cr. Clover *Corn* Cr. Clover	Cr. Clover *Tomatoes* *Cowpea Hay* Wheat	*Wheat* Mix. Clovers and Timothy	*Clover and Timothy Hay*
No. 5	Cr. Clover *Corn* Cr. Clover	Cr. Clover *Tomatoes* *Cowpea Hay* Wheat	*Wheat* Mix. Clovers and Timothy	*Clover and Timothy Hay*	*Potatoes* Cr. Clover

The above table shows a method of recording rotation No. 5 given in the table of rotations. This being a five-year, requires the division of the farm into five fields as represented in the column on the left. The remainder of the table shows the crops that will be grown in the different fields for a period of five years. Any rotation can be recorded in a similar manner, the number of fields depending on the length of rotation.

If a farmer is growing as much corn or wheat as tomatoes and potatoes combined, he could grow potatoes in place of cow-pea hay, with tomatoes in one field the same year. This would shorten the rotation one year. These two crops, being closely related botanically, require quite similar treatment regarding culture, combatting of insects and diseases, etc., that they might be grown satisfactorily in one field the same year, yet they would not follow each other more frequently than one year in four in the rotation.

TOMATO FERTILIZERS.

From a study of literature on this subject, it appears that there is a wide difference of opinion regarding the best fertilizer for tomatoes. This is to be expected, from the wide variations met in soils, and other conditions under which tests have been made. While these tests cover practically the entire United States, the varying conditions met in Maryland make it applicable in our State. Apparently authorities agree that the use of two or more mineral fertilizers combined with some organic forms give the best results.

Farmyard manure is a good fertilizer for tomatoes. The supply is generally limited in tomato section of this State, and growers rely on commercial fertilizers as the chief source of plant food.

All cover crops take up plant food from the soil, and change it to a more available form for succeeding crops. Leguminous crops add nitrogen. In supplying humus they bring about a condition more favorable for unlocking stored plant food by soil agencies. The grower should not fail to recognize this point, because he will be able, in most sections of Maryland, to reduce the amount of applied plant food, especially potash.

The three elements of plant food, Nitrogen, Phosphorus and Potassium are used for more or less specific purposes by the plant. By knowing something of their action in the growth of the plant, the grower will be able to make more economical use of fertilizers. It is also well to know some of the commercial materials from which these elements are obtained.

Nitrogen: There are four sources of nitrogen that are most generally used with the tomato crop. Nitrate of Soda, Sulphate of Ammonia, Dried Blood, Tankage. The relative availability of the Nitrogen in the four materials is in the order given.

Nitrogen is used by the plant in foliage and stem growth. It is essential that we have a strong vigorous plant if we expect a large yield. The start the plant gets when first set in the field influences the later growth, and resulting crop. Therefore, a good portion of the nitrogen should be applied in a readily available form. If the soil is in good tilth, and leguminous cover crops are grown, or farmyard manure applied, a fair amount of nitrogen necessary for plant growth later in the season will be furnished. This will permit of reducing the amount of organic nitrogen applied in blood or tankage, thereby, reducing the cost of the fertilizer.

Phosphorus: This is generally spoken of and known by growers as Phosphoric Acid. Acid Phosphate, Ground Rock, and Tankage are the chief sources of phosphoric acid used by Maryland tomato growers. For use on the tomato crop the phosphatic materials rank as given above.

Phosphorus is used by the plant chiefly in seed development. It is necessary, however, for the best development of root and stem.

The analysis made by this Station of the fruit and vines of tomatoes show that one ton contains:

	Nitrogen.	Phosphoric Acid.	Potash.
In Fruit—Lbs........	3.20	1.00	5.40
Vines (Green)—Lbs..	6.40	1.40	10.00
Total	9.60	2.40	15.40

From the above it will be seen that an analysis of the tomato shows it to contain a relatively small amount of phosphoric acid. Considering this, it seems difficult to answer why the growers use so much of this element in their tomato fertilizers. Most Maryland soils are known to be naturally deficient in phosphoric acid. This combined with the fact that the growers are using a fairly high percentage, seems to recommend the addition of more phosphoric acid to the fertilizer, than an actual analysis of the crop would show to be necessary.

Potassium: The chief sources of potassium are Muriate of Potash, Sulphate of Potash and Kainite. There is very little difference in value for tomatoes of the two first named potash materials, either being preferable to kainite under most conditions. On the other hand, the fact that some growers use kainite rather than other forms emphasizes the necessity of knowing local conditions and making local tests.

The tomato plant uses potassium in developing all parts. In fact it is found in larger quantities than nitrogen or phosphorus. *Patterson found that potash gives a tomato with less sugar and more acid. †Tracy says that potash gives a firm fruit with more acid and smaller vine. This would lead to the conclusion that potash is probably used as a basis of the fruit acid. Therefore, it is necessary to a certain extent in giving quality to the fruit.

McCue‡ reports that potash used by itself has been an aid in hastening maturity.

We might conclude from the above that the tomato fertilizer should contain considerable potash. However, nearly all Maryland soils are formed from potash-bearing rocks, and contain a relatively large natural supply of this element of plant food. The growers should remember this point and handle their soils to make use of it. Add humus, remove free water, allow the air to permeate the soil, till thoroughly, and we will unlock and render available potash from this natural store.

Knowing something of the uses that the plant makes of the different elements of plant food, and the sources of these elements, the grower should be able to make more economical applications of fertilizers. The soil condition is the chief determining factor in this work. Some farms have been more mined (everything taken out, nothing put back) than farmed, others farmed with a view to building up for future crops. This gives a wide range in possible soil condition. Tests made on the poorer farms will probably show a need of relatively expensive fertilization. The soils in good condition will indicate in most cases a possible reduction in the percentage of potash and possibly nitrogen necessary for maximum crop production.

Economical use of fertilizers can be determined best by the individual grower through experimentation.

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*Maryland Bulletin No. 11.
†Book on "Tomato Culture."
‡Delaware Bulletin No. 101.

For the poorer soils try a fertilizer analyzing 4-5% of nitrogen, 7-9% of Phosphoric Acid, and 8-10% of Potash. For a soil in the best possible condition try 2½-4% of Nitrogen, 7-9% of Phosphoric Acid, and 5-6% of Potash. These are given as guides to be tried under extreme conditions, changes can be made to suit the intermediate soils.

Apply from 600-1000 pounds of commercial fertilizer per acre. The actual amount will depend somewhat on whether farmyard manure or leguminous cover crops are used in growing the tomato crop.

Applying Fertilizers: Farmyard manure should generally be applied to a preceding crop. If applied directly to the tomatoes the best results will ordinarily be obtained by thoroughly composting the manure before applying.

Commercial fertilizers can be applied in different ways and at different times, However, applying part broadcast, and the remainder in or around the hill when setting the plants is a general practice and gives satisfactory results. If nitrate of soda is being used, apply it at planting time, or part can be reserved for a side application later. This method will reduce possible loss of nitrogen, which might follow if applied broadcast sometime before setting the plants.

PREPARATION OF SOIL FOR TOMATOES.

Prepare the land thoroughly before setting the plants in the field. Cover crops should be plowed down sufficiently well in advance of transplanting to permit the soil to settle and re-establish capillarity with the lower soil. This will give the green crops ample time to decay before possible dry weather sets in.

If the green crop is heavy it will work better to roll it down, or cut over it with the disk before plowing. Always where possible plow deeply, at least seven inches. Disk and cultivate thoroughly in order to get the soil in the best possible tilth before setting the young plants.

Too many farmers fail to realize the value of the roller in preparing their land. It breaks many lumps and will help to re-establish the connection between top and bottom soil, which is somewhat broken by plowing under a green crop. Harrow the land lightly soon after rolling to prevent excessive evaporation. The Acme harrow is a very good implement to use for this purpose.

TOMATO SEED AND ITS SOURCE.

One of the most important factors in growing tomatoes is the seed. The grower should known that the seed is true to name and of the best type of the variety. Corn growers have demonstrated that "quality" in the seed is the watchword of successful culture. This is even more important in tomato growing in Maryland, owing to the position it should have as a money crop.

There are three sources of seed supply for the grower. Seedsmen, cannery and the tomato field.

Seedsmen: The seedsmen should get together on their seed work. They are putting out so many strains of the different varieties, or even putting them out under new names that it is very confusing to the grower. In six plants of Stone seed from one firm tested at this Station in 1913, five were red and one pink, one of the red was rough and rather flat, evidently not Stone. Six plants of Stone from another firm's seed were not the variety named.

Canners and growers frequently are willing to buy seed because it is cheap. This is wrong, because it encourages dealers to put out inferior or mixed seed to fill the demand. Some seedsmen realize this point and catalog or advertise seed cheap to catch the trade.

The seedsmen have done good work in helping develop the tomato to its present standard. They can continue their good work by eliminating undesirable varieties and keeping the others pure and true to type.

Cannery: Unfortunately, some tomato seed has been saved from waste around canneries. This seed may give high percentage germination and strong plants, but generally the varieties will be mixed, in fact, almost anything can be looked for or expected. This should be absolutely stopped, because both canners and growers are losers. The grower should insist that the seed should be the best obtainable if supplied by the canner.

The Tomato Field: Satisfaction and reliability in seed can be assured, if saved from the growing field on each farm, or by one grower for a small section. Here the grower can study the plant and fruit and known something of their merits.

Have an "ideal" for the plant and fruit to conform to, keep this in mind when going over the field, and mark the plants accordingly. Study the plants when working among them. Then make the first selection while the plants are growing, marking with stakes those nearest the "ideal." Make a final tour of inspection through the field just before the first picking. Remove the stakes from any plants that have not developed according to your expectation and "ideal." Select vigorous, healthy plants, growing under normal field conditions. Do not select a plant because it is strong and vigorous if it stands out by itself in the field. Extra nourishment or other favorable conditions may cause this plant to appear abnormally vigorous. Warn the pickers not to take any fruit off the staked plants.

When the fruit is fully matured, pick the best for seed. Crush the tomatoes in a tub or barrel until it is two-thirds full and let it stand. This mass will ferment in a few days, depending somewhat upon the weather conditions. Then fill the receptacle with water and let it stand a few hours to settle. The pulp will rise to the top and can be poured off with the water, leaving the seeds in the bottom. It is a good plan to give the seed a second washing in the barrel. Let it stand a few minutes to settle as before, and pour off.

Empty the seed on a fine sieve to drain off surplus water. It can be left on the sieve, or better spread thinly over a piece of cheese cloth, and placed in a light, sunny room or other place to dry. Always take care to put the seed where mice or birds cannot get at it. When the seed is dry it can be put in thin cotton bags and hung up in a dry rather warm room. This will insure thorough drying which is essential for proper keeping. Some prefer to store the seed in glass jars, but care must be taken to have it thoroughly dry before putting it in the jars.

The canner might well afford to consider the question of seed selection for the purpose of supplying his patrons with seed of known quality. This will mean better and more certain results for canner and grower. The canner should not expect as high a per cent. of number one fruit delivered from seed of unknown quality.

The canner or a special grower can go further with this work. He can keep the seed from each hill separate when saving it. Plant the seed from the individual hills in rows or blocks to itself and study the development. This method of improvement can be carried on from year to year, until all fruit delivered to the factory can be the product of one hill in the original selection. This would mean uniform quality in the fruit hauled to the cannery. Starting with quality in seed and fruit, the grower and canner could each in turn put a more uniform produce of high standard on the market.

Crossing Varieties: *Wellington concluded, after conducting a number of tests, that crossing varieties of tomatoes for increased vigor and productivenes was a sound and practicable commercial operation. Tomato growers and canners should study and make use of this principle.

Desirable varieties as Stone, Matchless, Red Rock, should be selected for this work. Crossed varieties will break up into combinations of, or similar to, the parents in the second crop following the cross. This means that it will be necessary to make new crosses each year, or to cross enough one year for two or more years' seed supply. Owing to the fact that the germinating power of seed varies from season to season, depending upon conditions obtained, fresh crosses each year will probably give the best results.

A canner might find it profitable to specialize along this line of seed production for his patrons, or some good reliable man might take up the growing of seed in this way for a community.

TOMATO PLANT GROWING.

The open seed-bed method of growing plants is more generally followed in Maryland. One of the chief objections (lack of adequate protection) of this method was met in May, 1913, when many plants were killed by frost. Fortunately, this condition is not frequently met. The fact that we cannot be absolutely sure regarding spring frosts may turn the growers attention to a proected seed bed. The open seed-bed method will be treated in this part of the bulletin.

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*New York Agricultural Experiment Station Bulletin No. 346.

Select a well-drained and protected location of rather light warm soil for the seed. This can generally be found on the south side of a hedge, woods or buildings. If ample protection cannot be obtained as suggested, it will pay to construct a temporary one of pine boughs, cornstalks or some other material. Prepare the land thoroughly in order to obtain as fine a seed bed as possible. If the soil is not fertile enough, add some well-rotted farmyard manure, but avoid heavy fertilization with commercial fertilizers, especially nitrogen, as it tends to give a soft "leggy" plant which will suffer a heavy check when set in the field.

Rake the ground where the rows are to go just before seeding; this will help to pulverize the soil and better prepare the seed bed. Sow the seed thinly in rows four inches wide and twelve to sixteen inches apart. Sowing by hand will enable one to gauge the width of row and thickness of seeding. However, if the garden drill is to be used, sow four rows about one inch apart then leave a space 12″-16″ and sow four more rows as before. The drill should be so regulated as to sow the seed at least half an inch apart.

Thin the plants when two inches high, so they will average about two inches apart. This will give plenty of room for the young plant to develop strong and stocky, instead of "leggy" as is too often the case when not thinned. In extreme cases of long spindly growth, the tops can be cut back with shears. This will tend to cause the plants to grow stocky; but the necessity for clipping the tops should be avoided if possible, rather than generally used as corrective for an undesirable condition.

SETTING TOMATO PLANTS IN THE FIELD.

There are two methods of planting, check and row (step as it is called in some sections). For canning tomatoes the check 4′x4′ or 5′x4′ is generally preferable, however, with varieties that produce comparatively small vines, the step method 5′x2′ 6″ will give good results. The check method permits of working both ways, thus somewhat reducing the amount of hand work and cost of subsequent cultivation.

When the transplanting machine is used it will be difficult to plant in checks unless the land is previously cross-marked. Then the accuracy and neatness of the planting depends upon the care and skill of those handling the plants.

The best hand tool to use in setting is a trowel. This will be found somewhat slower than the dibble (planting peg), but will generally give better results.

Some growers mark the rows one way with a board marker and use a disk marker for marking the other way and opening the furrows. The planters follow, setting the plants at the check against the straight side of the furrow. They hold the plant in place with one hand, and pull a quantity of earth over the roots with the other. Step on the loose soil in passing to the next plant, to pack it well around the roots. This is a rapid and satisfactory method.

Transplanting should be done on a dull cloudy day if possible. Avoid windy weather, it causes the roots to dry out rapidly if exposed for only a short time. The person dropping the plants should not have more than two or three dropped in advance of the planters.

Never pull plants from the seed bed, because too many useful roots will be broken off, especially if the bed is a little dry or hard. Water the seed bed a few hours before removing the plants, if the weather has been dry for a few days. Loosen the soil with a spade, then lift the plants out carefully to avoid injuring the roots. Place the plants in a basket or box for carrying to the field, and cover it with an old piece of sack or something to shade the plants.

Some growers practice puddling the roots in a thin mud paste before setting in the field. If it is necessary to plant during a continued dry spell or on a windy day, puddling the roots will enable the plant to stand up better. Under general weather conditions if the soil is in good tilth, and the plants stocky and vigorous, puddling need not be practiced.

Care of the Tomato Crop.

Start the cultivator as soon as possible after plants have been set. If the disk marker or plow has been used to open furrows, cultivate across these the first time. The first cultivation should be fairly deep, and regulated to throw a little soil to the plants. This cultivation will loosen the soil, where tramped incident to setting the plants.

Subsequent cultivation should be frequent, and gradually working shallower and farther from the plants. The chief object of this cultivation is to conserve soil moisture by a light surface mulch. After the second working, one inch is deep enough to cultivate. The practice of cultivating every second middle at one operation, then going back in two or three days and cultivating the remaining spaces, is not necessary. Regulate the depth of each cultivation so as not to disturb the roots, and work each row in turn.

Careful handling of the cultivator and working across the field will reduce hand work to a minimum. In the average field, with good cultivation, it should not be necessary to hand hoe more than twice.

Start the cultivator to work as soon as the soil will permit after a rain, to prevent a crust from forming, and excessive evaporation. Cultivation must stop when there is danger of injuring the plants and fruit. The time will depend upon the distance apart of the plants. With 4′x4′ planting, cultivation will ordinarily stop when the first fruit is about 1″-1½″ in diameter. The vines will shade the ground sufficiently to prevent too much evaporation, and cultivation is not as essential as earlier in the growth of the crop. Sow crimson clover or other cover crop with this last working.

Tomato Harvesting.

Let the tomato mature fully. Pickers must be watched carefully because they are very liable to handle the ripe tomatoes too carelessly, or pick green fruit thinking it will stand rough handling and fill the baskets more rapidly. The canner does not want green fruit, it means unnecessary waste. It is also more difficult to pack a product that will conform to the requirements of the Pure Food Laws if the grower delivers half green or decayed fruit to the packing house. Handle the fruit carefully at all times, and deliver only the standard of fruit called for in the agreement between grower and canner.

Many growers become anxious about their tomatoes, especially early in the season. The field appears red and the growers decide the fruit must be picked to avoid loss. In many instances it would pay to let it stand for a few days. This will reduce the chances of delivering green fruit, and if sold by weight, which is best, the ripe fruit will weigh heavier.

A Word to Tomato Canners.

There are many farmers, who, through careful seed selection or other cultural work, are delivering a large percent of number one tomatoes to the factory. Tomatoes that will give two or three, or more cans per bushel above the average delivered. What recognition or encouragement do these men get? Should they not receive some? For the best interests of the tomato grower and canner some premium should be put on quality of fruit delivered to the factory. This will enable the packer to put out a larger percent of number one and fancy goods.

The canner who will pay according to quality of fruit will very soon be able to discriminate in grade of fruit taken in. It will eventually remove the necessity of cutting growers who deliver green, rough, or cracked fruit, by assuring them that you want and are willing to pay for "quality."

The canners' and growers' interests are similar in the tomato industry. The uniform, smooth, solid tomato the canner finds most satisfactory, is most satisfactory for the grower. The sooner the two interests realize this, the better it will be for the tomato industry in Maryland.

Methods of Starting Tomato Plants.

The following table and photographs, reproduced by courtesy of "Purdue University, Department of Horticulture, Lafayette, Indiana," show results of different methods of starting plants.

METHOD	Cost Plants Per Acre	Yield Per Acre	Value crop per Acre less cost of Plants.
Seed-Bed Plants	$1.30	Tons. 5.26	$51.30
Hot-Bed Plants Not Transplanted	4.90	10.15	96.60
Hot-Bed Plants Transplanted Once.	4.95	10.30	98.05
Hot-Bed Plants Transplanted Twice.	6.70	10.82	101.50
Hot-Bed Plants Grown in Dirt-Bands.	8.80	14.92	140.40

Summary of results from five different methods of growing and handling plants after three year's tests.

The above table compares the methods from the standpoint of cost of growing plants, yield and value of crop less cost of plants. The crop value is taken at $10.00 per ton for cannery fruit. This price per ton is probably a little higher than the average paid in Maryland. The possible net returns for each method can be obtained by substracting $36.21 from the value of crop per acre less cost of growing plants, under each of the five methods. The $36.21 which represents the cost of production per acre is obtained by subtracting $2.40 average price per acre paid for plants in this State, from $38.61 estimated cost per acre given in the tomato culture section of this bulletin.

This question is worth consideration for Maryland conditions. The larger yields and net returns from hot-bed grown plants given in the above table, are doubtless due to having a stronger plant, which could withstand transplanting into the field better than the seed-bed grown plants. The hot-bed method, by affording protection, will assure the grower of having sufficient plants to set the required field. This means a more perfect stand with one planting, which in most cases will offset the additional cost of plants, in yield of fruit, over the seed-bed method.

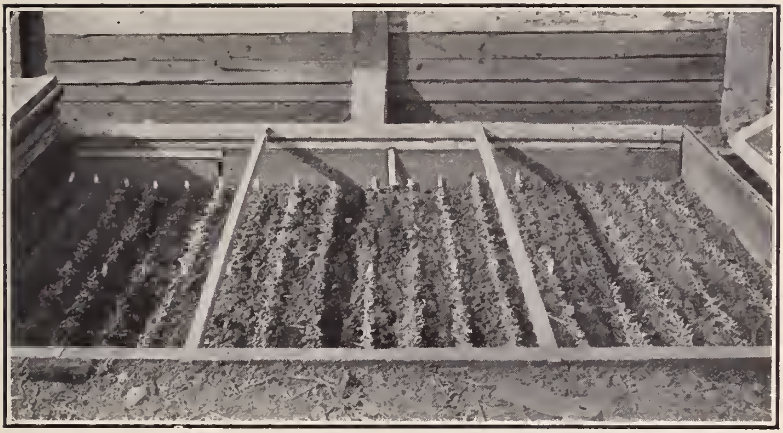

Fig. 1.—A hot bed with sash removed built behind a wooden windbreak to protect it from cold winds. The tomato seed are sown the last week in March in rows six inches apart across the bed.

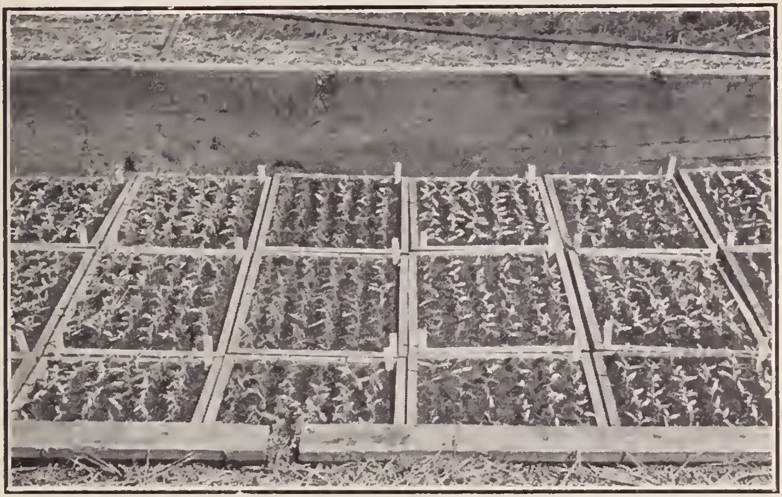

Fig. 2. Seedling tomato plants in flats just after transplanting.

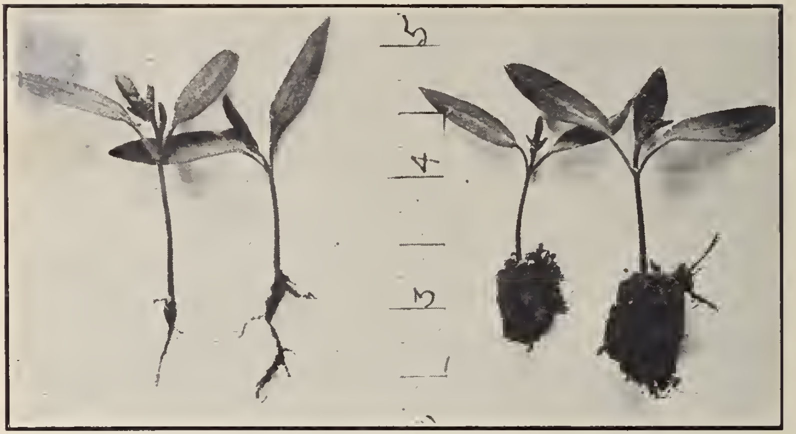

Fig. 3.—Size of tomato seedlings when ready for the first transplanting. Remove the plants with soil on the roots as shown on the right.

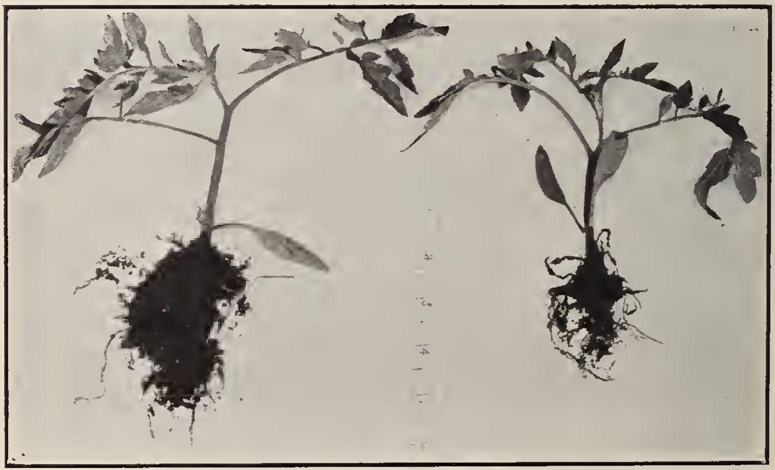

Fig. 4.—Size and condition of plants at time of second transplanting.

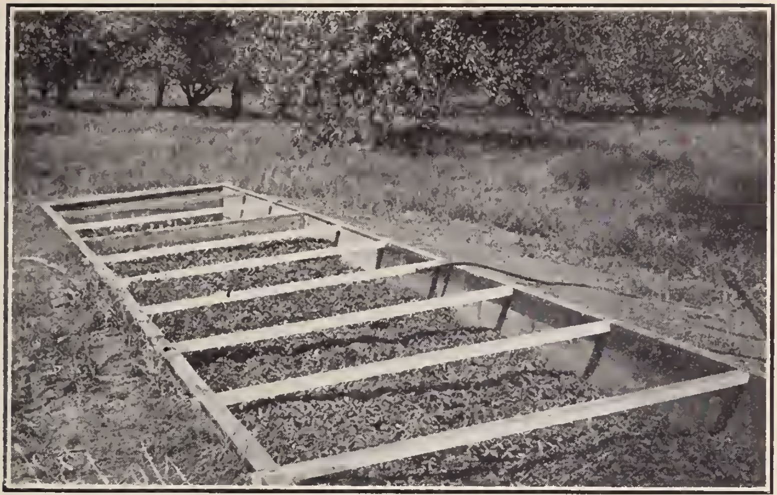

Fig. 5.—Hardening of plants in the cold-frame. The sash are removed entirely for two weeks or more before time for setting the plants in the field.

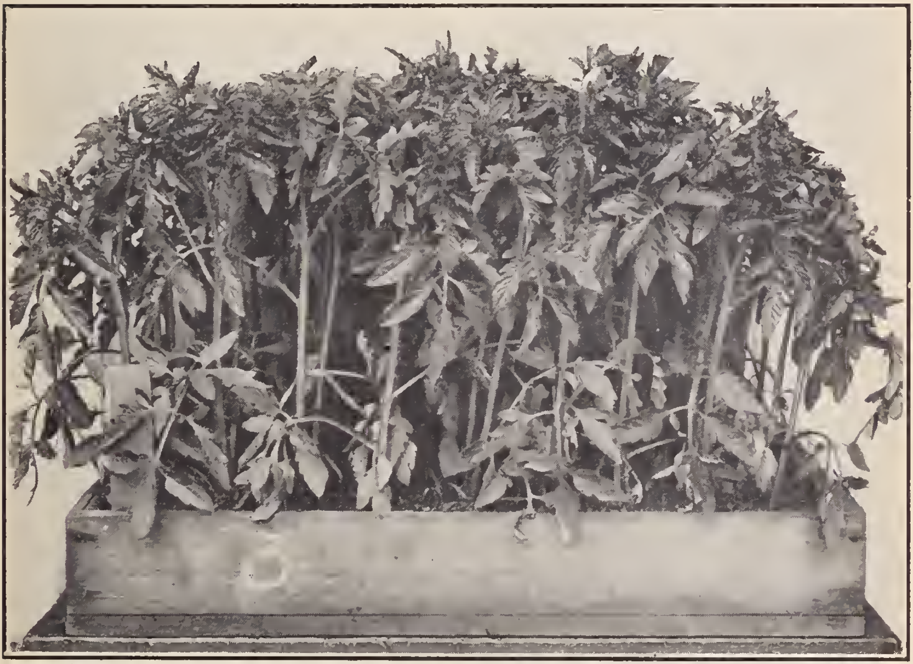

Fig. 6.—Showing plants ready for setting in the field. These had been transplanted from the seed bed to the flats.

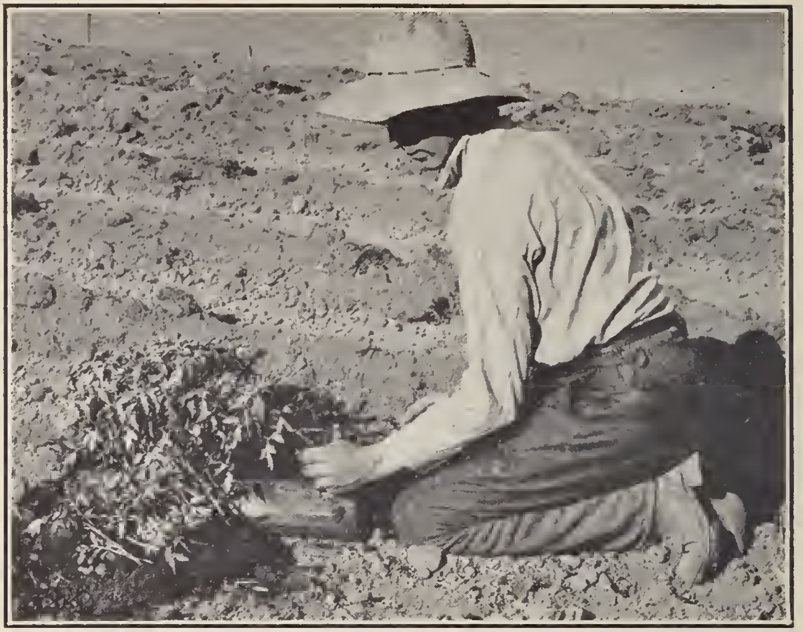

Fig. 7.—Removing plants from the flat for setting in the field.

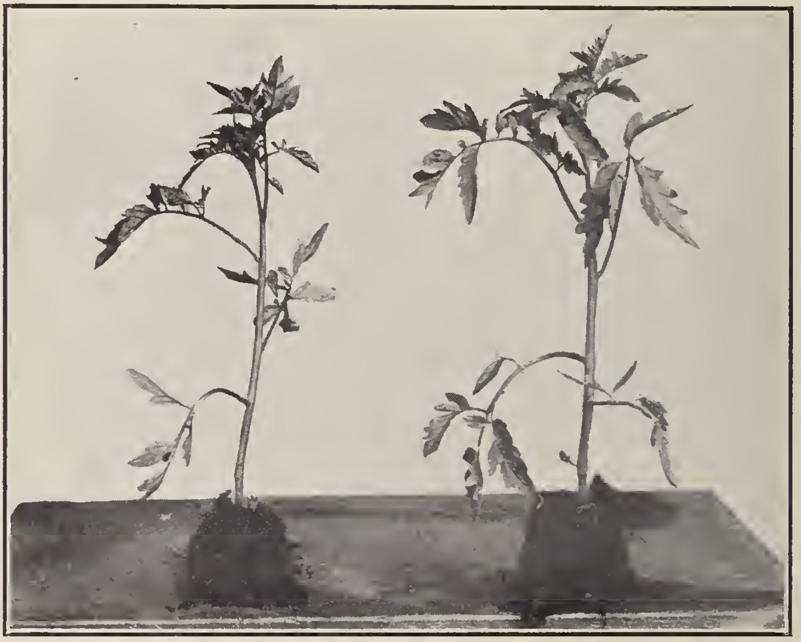

Fig. 8.—Plants removed from flats for setting in the field. Note the ball of earth on the roots.

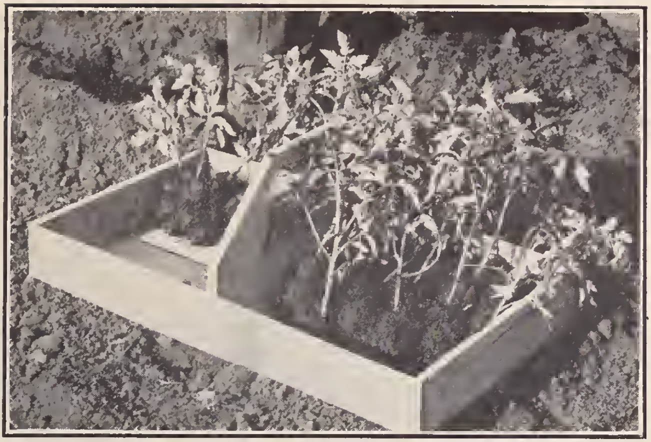

Fig. 9.—A convenient carrier for distributing plants through the field.

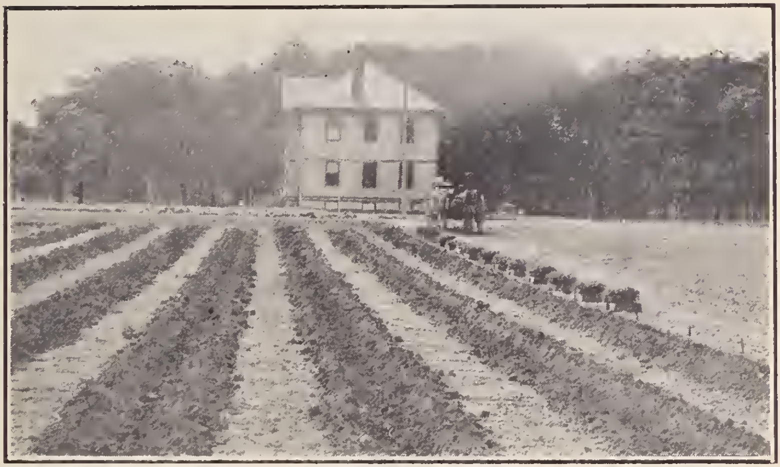

Fig. 10.—Furrows open, and plants distributed through the field in the flats ready for planting.

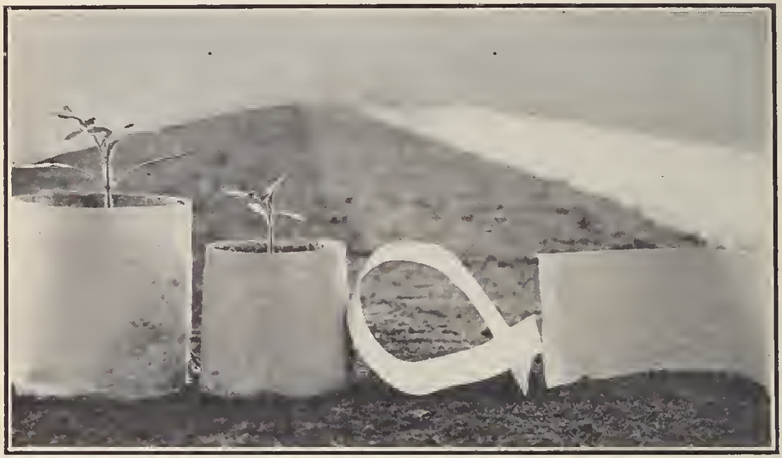

Fig. 11.—Plants growing in dirt bands. A sure way to get the best type of plants for transplanting.

THE MARYLAND AGRICULTURAL
EXPERIMENT STATION

BULLETIN No. 181 MARCH, 1914

INEXPENSIVE AIDS IN PRODUCING SANITARY MILK.

By R. W. Lamson.

Summary.

1. The average dairyman can produce a much cleaner and more profitable grade of milk at a small additional cost. This result can be secured by following simple and inexpensive methods of milking, and will materially reduce the bacterial content of the milk.

2. Discarding the first streams of fore-milk decreased the bacterial content.

3. The small top milk pail was more efficient than the open pail, and several so-called sanitary pails, in lowering the bacterial content.

4. Many of the sanitary pails were complicated and difficult to keep clean.

5. Glycerine, sweet oil or vaseline used on the udders had a pronounced effect in reducing the number of bacteria found in the milk.

6. Clipping the udder proved desirable, both from the sanitary standpoint and from the point of labor economy in cleaning and milking the cows.

7. A combination of these various methods had the effect of reducing the average bacterial content in one case to one-third, and in another case to one-tenth of the original count.

Introduction.

The production of Sanitary Hygienic Milk is rapidly becoming a question of great importance, primarily because of the greater healthfulness and better keeping properties of such milk, and, secondarily, because of the cost of production in relation to the price of the commodity. It is an indisputable fact that mere numbers of bacteria in milk have a detrimental effect when that milk is fed to young children. Many mortality tables have been worked out to support this fact. Numbers may also exert a detrimental influence upon even healthy adults. The section of the Dairy Division, United States Department of Agriculture, in charge of "Sanitary Milk Production," has had under its observation the milk supply of the United States Naval Academy; and also the sick reports of that institution, especially reports of sicknesses such as intestinal troubles which often arise from consuming unclean milk. About a year ago the milk supply for the Academy was greatly improved, especially along sanitary lines, with a resultant pronounced decrease in the cases of intestinal troubles. Thus, it would seem that mere numbers of bacteria do affect the health of the consumer. Of course, this refers to non-specific organisms causing such conditions as diarrhea, and does not include any specific disease germs like the diphtheria or typhoid fever organisms which may get into the milk. These are very likely to be detrimental to any one consuming them, even in small numbers. Therefore, it seems important that the consumer demand milk of low bacterial content, as that is at present our only measure of the cleanliness of the milk.

Aside from the wholesomeness of the milk, certain chemical changes may be brought about by the bacteria. Sour milk is at best, an undesirable and unsalable product. Early souring of milk often results in the loss of many customers. Milk that has to be shipped long distances is apt to be received sour, especially if it started with a large number of bacteria. Milk that is absolutely free from bacteria will keep sweet for many weeks. There is quite a definite relation between the number of bacteria and the amount of acid produced. Here again numbers mean something.

There is, however, the producer's side of the question. It is a misrepresentation to state that clean hygienic milk can be produced without any extra cost or labor. On the other hand, sanitary milk always finds a ready sale, and sometimes at a premium. It would be nearer correct to state that as large or greater profits can be made by the production of cleaner milk.

Many of the requirements as laid down by the dairy score-card are expensive, and sometimes not absolutely necessary for the improvement of the sanitary quality of the milk. Various investigators have reported their findings on certain practices—such as discarding the first streams of fore-milk—used in an attempt to produce cleaner milk. Some have recommended this practice; others claiming that it is a useless waste of time. Various types of pails have been tried out, but very little comparative work has been done covering all seasons of the year.

In a recent publication, Harding, H. A.,[1] et al., reported that many of the dairy refinements heretofore considered necessary, have little or no effect upon the germ content of the milk. "The dairy operations found in our tests to have no value in keeping down the germ content of milk were: (1) Ceiling the stable with lath and cement, and whitewashing the interior, and painting the woodwork; so that it may be said that the cleanliness of the interior of the stable, within a fairly wide range has no measurable effect upon the milk. (2) Clipping the udder, flanks and adjoining portions of the cow led to a slight increase in the germ content of the milk when the cow was cleaned either by hand or with a vacuum cleaner. (3) Cleaning the cows with a vacuum cleaner at the rate of one cow per minute resulted in practically the same germ content of the milk, as cleaning with a brush and comb at the rate of two cows per minute.'' A glance at the averages in that publication will show that there is no pronounced difference between the various modifications and it appears that the contrasting conditions were not well selected. It was noted here at this Station, that soon after clipping the cows, there was a slight increase in the germ content of the milk, probably caused by loosening the finer dirt near the skin. Still that does not seem to warrant the discouraging of the process, when the time factor in keeping the cows clean is considered. It seems somewhat unfortunate that results such as these, which are at variance with the findings of many equally competent authorities, and the foundations of modern sanitary dairying, should be published as a popular bulletin. No matter how carefully the work may have been done, it would seem that it should have been published in the form of a purely scientific article, so that others could criticise or corroborate the results.

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[1] Harding, H. A., et al., Bulletin No. 365, New York Experiment Station, Geneva, N. Y.

Without doubt much time is spent doing things that have but little effect on the final number of bacteria. This time must be paid for, and the little additional price of sanitary milk does not perhaps fully recompense one for the extra trouble. However, that is not the fault of the system, but rather of its application. It is the purpose of this bulletin to give results of work carried on in an attempt to lower the bacterial content of milk without adding materially to the cost of production.

Plan of the Experiment.

The original plans of this experiment were divided into several separate lines of work, but due to many changes, these lines merge more or less. I will give the original plans and these may aid in interpreting results:

1. A comparative count of the number of bacteria in milk drawn in several types of pails.
2. Effect of discarding fore-milk.
3. Use of various substances on the udder, teat, etc., to reduce contamination of milk from the cow.
4. A combination of these methods showing effect of such simple operations on the final number of bacteria in 1c.c. of milk. The various conditions under test in each section of the work were indicated by numbers, or letters, to facalitate recording results. These

numbers or letters are used in the tables, and explanation of numbers follows.

In every case the cows were cleaned, usually once a day, and the udders were wiped with a moist cloth previous to milking. No more attention was paid to the care of animals, barn, or milking utensils than would be ordinarily used by any practical dairyman. The milk pails were sterilized by live steam.

Condition 1. All milk collected in an open top pail.

Condition 2. First two of three streams of fore-milk discarded, remainder collected in open top pails.

Condition 3. Osborn's clean milk pail was used to collect entire volume of milk from one cow.

Condition 4. Small top pail, coal hod type.

Condition 5. Partly closed top pail with side strainer spout.

Condition 6. Johnson's Anti-dirt pail.

The conditions used in a comparison of various substances with water alone as a wash for udders and teats, are indicated by letters, with exception of Condition No. 1, which is the same as previously described. All the samples were collected in an open top pail, so any difference in count should be partly due to modified conditions.

Condition 1—Water.

Condition A— 50% glycerine.

Condition B—100% glycerine.

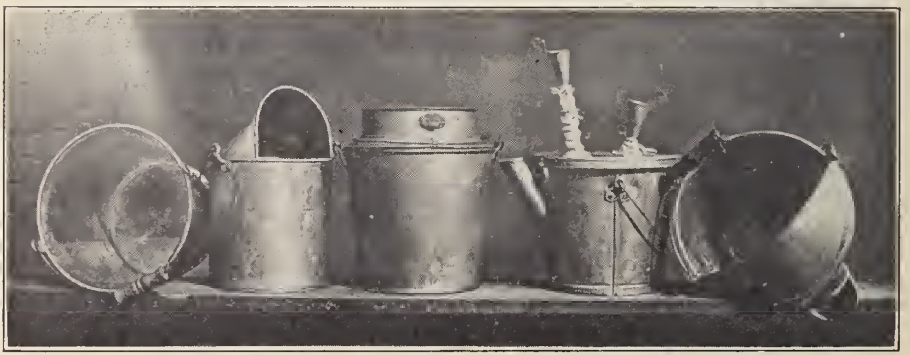
Condition C—Sweet oil.

Condition D—Vaseline (used only during the latter part of this work).

Condition E—Cow clipped and milked into open top pail. And lastly a combination of conditions which proved most efficient in the above-mentioned experiments. Namely, Conditions 2, 4, D and E. See Table 8 for results.

Conditions 1 to 6 and A to C were tested throughout the entire year for a period of two weeks to a month under as many climatic conditions as possible.

Figure 1.—Type of pails used in comparative tests.



1.—Open pail. 4.—Small top coal-hod type. 6.—Johnson's Anti-dirt pail. 3.—Osborn's Clean-milk pail. 5.—Partly closed top.

TECHNIQUE.

Samples were taken with sterile 10 cc. Mohr's Pipettes, from the milk as soon as a cow was milked. The entire contents of the pail were stirred before taking the sample. The samples were prepared and plated as before described.[2] Two or more plates were poured for each sample, and they were inverted and incubated at 22°-23°C for four days.

In the following table the counts of the various conditions or modifications as used on several cows are given. Unless a modification was tried more than a half dozen times, it was not included in this table, but is given collectively in Table 3.

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[2] See Bulletin 177 of this Station.

Table 1. Counts for individual cows.—Bacteria per cubic centimeter of milk.

Condt.	1	2	3	6	B	C
Cow No.	4600	3125	1200	1200	1600	7800
136	750	1000	900	950	700	3000
	4500	2500	1200	1850	900	1100
	1150	1900	1450	1950	900	2900
	9500	4100	1700	6600	800	950
	4900	3150	1050	9000	1850	3550
	13575	1600	2800			
	4500	2000	4200			
	19600	2000	1000			
	14500	4400	2100			
	8000	6400	4750			
	9000	1300	5000			
	1100	5900	6100			
	6000	3900	2000			
	2000					
	3350					
	1450					
	1900					
	4250					
	3750					
	3250					
	4800					
	3050					
Total	129475	43275	35450	21550	6750	19300
Average	5629	3091	2532	3591	1125	3216

Condt.	1	2	4	5	6	A	B	C
Cow No.	5800	3100	900	3000	850	5500	8000	1600
155	5200	1000	2550	4400	1750	1633	3600	3066
	1600	4750	3350	2250	2350	2975	8700	10200
	3800	2100	7150	3400	3000	2000	6300	1200
	8000	4350	3350	2100	2100	1000	1700	1400
	4800	5650	4750	2950	7150	13300	1850	900
	3300	3750	5600	15650	9650	2200		2100
	5350	2500	6800	4000	15300	1350		3100
		4950	2850		4000	22350		
		45200						
		27800						
		6400						
		6700						
		3900						
		4733						
		17566						
		3500						
		3725						
		4700						
		6000						
		5766						
		4500						
		21200						
		2250						
		1725						
		2375						
		2125						
		2100						
		14000						
		7400						
		3300						
		1250						
		1500						
		3400						
		2550						
		1500						
		6250						
		8800						
		10600						
		5500						
Total	37850	270465	37300	37750	46150	52308	30150	29566
Average	4731	6761	4144	4718	5127	5812	5025	3285

Condt.	1	2	4	5	6
Cow No.	5500	800	4200	2100	7500
159	4300	5050	1000	1900	1900
	1500	3350	700	8950	700
	3600	2650	4300	4000	5500
	2250	2050	3000	3500	4450
	4500	6350	1800	5550	2400
	1100	1300	1400	1950	4200
	3100	1150	2350	7500	7100
		850	8800	1800	6900
			2500	1800	3700
			2900	2250	1100
			1050	2900	3800
			1100		
			1700		
			1500		
			2900		
Total	25850	23550	41200	44200	49250
Average	3231	2616	2575	3683	4104

Table 1.—Continued.

Condt.	1	2	3	4	5	6	A	Condt.	1	2	5	Condt.	2	A	B	C	Condt.	1	2
Cow No.	14500	8500	3550	14200	20700	6150	5900	Cow No.	8100	4200	3500	Cow No.	43500	7800	18750	25000	Cow No.	4300	900
129	5300	8800	4250	12325	5500	7300	8150	163	5400	2550	4100	69	12445	6800	3375	9600	128	1800	2700
	21600	3450	8500	2375	4900	49300	650		7300	4200	23500		44600	11850	17000	18000		3600	3800
	16950	8500	800	1500	5400	12700	1400		16800	10150	22400		11700	26000	5625	20900		3600	4500
	1700	7500	3700	4000	3350	30800	1500		4000	17250	10200		9200	23000	9300	10700		2100	2000
	4700	14100	900	1400	8300	20250	2100		19000	7350	12200		12600	34066	9500	8600		3600	4350
	2000	24500	2400	600	15900	2700			6500	2700			10000	34466	12300	10500		1900	1800
	2200	2750	3200	1250	26250	3100			6000	4400			17700	19925	35700			9100	1050
		2600	1300	1500	2250	5500			4400	7500				9500				3000	1100
		1800	3050	3766	2900	5200			5000					11025				5500	1550
		3100	4550	12033	2600				3400					15650				3200	4800
			5100	9200	16900				7700					6500				1300	9650
			8000	4700					5400					3933				5200	1100
			4150	800					9300					8500				9200	6500
			97500	2900					6500					15500				8600	5550
			7750	2100					12250					11300				1100	1350
			14500	3100										18400				3500	800
			17500											11900				1100	2300
			20200											11200				3200	6400
			15400											8200				1350	1200
			13000											17200				2000	6000
			19200																2500
			500																1600
			2650																700
			5500																8050
			8700																3900
																			4200
Total	68950	85600	275850	77749	114950	143000	19700	Total	127050	60300	75900	Total	161745	312715	111550	103300	Total	78250	90350
Average	8618	7783	10609	4573	9579	14300	3283	Average	7940	6700	12650	Average	20218	14795	13943	14757	Average	3754	3346

Table 1.—Continued.

Condt.	3	4	6	Condt.	2	A	B	C	Condt.	1	2	3	4	5	6
Cow No. 146	3700	13200	9000	Cow No. 56	6500	12500	4600	2250	Cow No. 195	9800	3250	1300	22400	450	4750
	4733	6500	11200		3200	12450	10800	1100		1400	3300	2500	700	1400	14200
	7900	12850	11900		5400	10500	5600	1400		14400	1800	1900	2050	9900	1500
	1450	12900	9200		8300	14600	3200	8300		7000	5200	1500	1600	6300	4300
	2850	6800	4250		6000	6000	7600	5733		3700	2150	700	1350	6800	13200
	2250	4950	23500		3800	3200	5800	3066		6500	2000	3800	500	2400	9400
	4400				4200	7100		2750		10200		2500	19000	2700	3300
	2550				3000	3000		3933		2400		1950	3000	2800	7000
	4350							6250		4000		1250	2200	2400	800
	8000							9500		6500		1350	1600		36000
	3000							11000		2100		6900	2600		1500
	9050							16566		8900		4400			
	14700							8750				2050			
	43300							5250				2850			
	12000							3625				2000			
								7600				1100			
								7000							
								5000							
								5300							
Total	124233	57200	69050	Total	40400	69350	37600	114373	Total	76900	17700	38050	57000	35150	95950
Average	8282	9533	11508	Average	5050	8668	6266	6019	Average	6408	2950	2378	5272	3905	8722

Table 2. Summary of Table 1, Showing the averages in round numbers.

Condt.	1	2	3	4	5	6	A	B	C
Cow No.									
136	5600	3100	2500			3600		1100	3200
155	4700	6800		4100	4700	5100	5800	5000	3300
159	3200	2600		2600	3700	4100			
129	8600	7800	10600	4600	9600	14300	3300		
163	7900	6700			12700				
69		20200					14800	14000	14800
128	3800	3300							
146			8300	9500		11500			
56		5100					8700	6300	6000
195	6400	3000	2400	5300	3900	8700			

From Table No. 2 it will be seen that in six cows out of the seven where Conditions 1 and 2 were used, the average for Condition 2 is some lower than the average for Condition 1. This difference is due almost entirely to the modification used, namely, discarding the first few streams of fore-milk.

Condition No. 3 gives fairly good results as compared to No .1, but it was only possible to use this modification on the cows with nearly perfect udders and teats, also the easiest milkers. The reason it was not used on more cows being, that it was nearly impossible to do so, due to short teats or rather hard milkers. Toward the last of the milking, the difficulty of using this pail increases very rapidly, taking much more time than should be given to milking a single cow.

Condition No. 4 in every case gave an average lower than that of No. 1. This will also be noticed in Table No. 3, where this condition was used a few times on many cows. The pail is easy to clean and not difficult to use.

Condition No. 5 did not give especially good results, and there seems to be no special advantage in having such a small section of the top covered. It is neither an open nor a small top pail.

Condition No. 6 in every case but one, gave exceedingly high results, and it seems very easy to explain the reason for this. The top of the pail is a flat fine mesh wire strainer. A hair or the least particle of dirt or manure falling on this wire strainer is washed nearly free of bacteria. The lumps of dirt or manure are also broken up. If they fell into an open pail they would soon be away from the main force of the streams of milk, and fewer bacteria would get into milk from this source. This point has strong proof in the fact that cow No. 136 gave a low count with this method. She was a short-haired cow that never seemed to get dirty, and even with Condition No. 1 it was very seldom that hair or dirt would be noticed in the pail.

Condition A gave fairly good results (See also Tables 4 and 5), but it will be noticed that in nearly every case when compared with methods B, C and D it is usually the highest of the four.

Table 3. Counts on several cows-conditions as noted.—Bacteria per c. c. of milk

Condt.	1	2	3	4	5	6	A	B	C	D
	43400	4300	30500	1000	1000	15500	1200	1500	1800	4050
	19000	1000	11000	1050	800	16800	2100	2700	7900	2000
	24500	2000	3500	5200	1000	4800	2300	1300	1450	1700
	16775	2600	1600	5200	2100	5000	2500	2100	2250	6600
	3000	4500	2450	2350	4000	1650	950	6700	3250	6350
	800	1700	9700	10500	1500	21200	5400	3700	5450	5600
	900	1000	5400	2850	7700	9000	7100	4900	5200	4700
	2600	3300	1600	10800	800	11200	7200	4400	8000	4600
	5000	1600	13000	5000	7300	11900	7500	4600	6600	10300
	7500	2550	3500	14600	8100	9200	7250	2000	1100	5950
	6500	4000	22400	1900	9600	4250	6000	2150	2850	3050
	9000	2700	3200	1300	7700	23500	550	700	1950	2600
	7300	5000	3300	2250	7000	6500	2700	2500	3000	2600
	1000	11000	2200	800	500	3900	2400	5600	1750	300
	3500	4000	1600	3900	5800	11700	2050	700	800	2700
	7100	6750	5000	3650	1600	1000	2500	800	2550	400
	7200	4200	7600	3450	5800	500	1300	2650	500	1750
	3900	5100	2700	3600	4000	3250	3300	3150	9800	200
	3200	18250	8200	1700	4800	2500	2500	2250	1700	2000
	10700	7500	17000	3200	1200	5000	2500	2300	2300	2200
	15500	7800	27800	6200	3800	7000	2300	2300	1000	1800
	6900		4100	6300	6000	8100	4250	800	1750	1250
	5700		41800	2450	4500	9500	1850	2600	2900	2450
	10950			2800	6400	8800	4500	2700	800	900
	4700			7900	6000	5500	4000	3100	1350	2450
	4800			6000	5000	7500	6000	16400	2850	3800
				2850	6200	6500	6000	14900	8600	4000
				2200	5600	2300	3300	4900	4500	1500
				1400	16000		4300	3400	3100	5000
				5000	3600			6200	1800	
					3300				3000	
					3500					
					6700					
					4100					
Total	221425	100850	229150	127400	163000	223550	105800	114000	101850	92800
Average	8516	4611	9963	4246	4794	7983	3648	3800	3285	3200

From the above table, taking the averages to the nearest hundred, it against appears that there is an advantage in discarding fore-milk, or in using a small top pail. Condition No. 6 again gives highest counts of any of the modifications. Of the udder treatments, sweet oil (C) or vaseline (D) give exceedingly low results as compared to those obtained by No. 1.

The counts given in previous tables were all on evening milking. It was suggested that there might be a difference in the number of bacteria in the milk drawn in the morning and in the evening of the same day. It was decided to obtain some information on this subject, so the same conditions as previously used werre tried at night and again the next morning. A cow was tested with the same condition one night and the next morning. Then this modification was moved on to the next cow in the series, and another modification was tried on the other cow. Thus, each cow had the various condition tested on her. (See Tables 4 and 5 for results.) These include counts on ten cows. In this way it was hoped to minimize the influence of the individual cow. These tests were continued uninterrupted, except for Sundays, throughout a period of about four weeks.

Table 4. Counts of morning milk, various methods of producing milk being used.

Condt.	1	2	3	4	5	6	A	B	C	D
	1600	4400	3000	2900	12300	500	8150	2700	7900	3300
	20000	3000	2650	3100	2900	12000	1400	2100	2250	1700
	3050	2600	8700	14600	16900	3100	2100	3700	5200	6350
	4700	3100	11000	1650	8100	5200	7100	4400	6600	4700
	2200	7350	14700	1700	7000	5000	7500	4600	2850	10300
	19000	4400	12000	6500	2800	11200	6000	2150	3000	3050
	6000	4000	1100	12900	1800	9200	550	2500	800	2600
	5000	11000	10700	4950	2900	23500	2400	700	500	2700
	7700	5200	2450	2200	5800	7000	1300	800	1700	1750
	9300	2000	5400	2600	1600	800	2500	3150	1000	2000
	12250	850	13000	2900	4000	1500	2300	2300	2900	1800
	1700	1600	22400	3650	1200	3800	4250	2600	1350	900
	6500	8050	3300	1700	6000	11700	4000	3100	2850	3800
	7300	4200	1600	6200	6400	2500	6000	4900	4500	4000
	6500	6750	7600	2450	5000	8100	4300	6200	3000	5000
	8900	11500	900	2800	5600	8800				
	4250	2800	2700	6000	3600	7500				
	3100	5100	17000	2200	3500	2300				
	3200	7505	41800	5000	4100	2100				
	2000	4500								
	3500	2500								
	7200	7800								
	12500	1300								
	2500	1300								
	1200	7550								
	3200									
	5500									
	3000									
	2700									
	6800									
	10950									
	4800									
	12400									
	3900									
Total	306800	120350	182000	86000	104500	125800	59850	45900	46400	54950
Average	9088	4628	9578	4526	5500	6621	3990	3060	3093	3663

Here again Conditions No. 2 and No. 4 show a decided advantage over Condition No. 1, as also does A. B. C or D.

Table 5. Counts of bacteria per c. c. evening milk, various of methods of producing milk being used

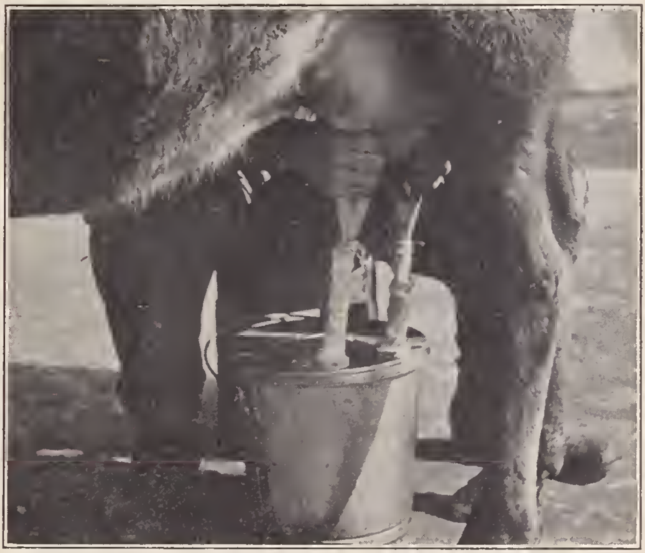
Condt.	1	2	3	4	5	6	A	B	C	D
	4800	17250	500	1600	2250	1800	5900	1500	1800	4050
	1700	1150	5500	800	2600	1000	650	1300	1450	2000
	2000	2750	30500	2100	10200	2700	1500	6700	3250	6600
	4000	1800	8000	5000	7300	5500	5400	4900	5450	5600
	6500	2700	9000	13200	9600	4800	7200	2000	8000	4600
	4400	2550	43300	12850	7700	9000	7250	700	1100	5950
	3400	2700	2000	6800	2700	11900	14600	5600	1950	2600
	5400	5000	3500	3000	2400	4250	2700	21000	1750	300
	6500	3300	1600	1500	1800	3300	2050	2650	2550	400
	7500	1800	9700	3900	2250	36000	2500	2250	9800	200
	9000	2300	1600	3450	500	1100	3300	2300	2300	2200
	2100	2150	3500	3600	5800	6500	2500	800	1750	2450
	1100	2750	3200	3200	4800	3900	1850	2700	800	2450
	1350	6350	2200	6300	3800	1000	4500	16400	8600	1500
	1000	10800	5000	21600	4500	3250	6000	14900	3100	1250
	7100	2500	8200	7900	6000	5000	3300	3400	1800	3400
	3000	700	4100	2850	6200	7000				
	12000	3900	1900	1400	16000	9500				
	2100	4000	28700	3150	3300	5500				
	3900	6500	1600	1100	6700	6500				
	10700	300								
	6900	4200								
	3500	18250								
	24500	3000								
	7500	3600								
	2800	4700								
	5700									
	4700									
	2400									
	4500									
	4000									
	11400									
	1100									
	4000									
	3200									
Total	185750	117000	173600	105300	106400	129500	71200	89100	55450	45550
Average	5307	4500	8680	5265	5320	6475	4450	5568	3465	2847

A slight advantage in favor of No. 2 over No. 1 and a big advantage in favor of Conditions B or D. From the averages it will be seen that the evening milking gave six out of ten methods tried lower that for the corresponding methods as used in the morning. Thus, no pronounced difference is noted between the morning and the evening milking, when a long period of time covering several cows is considered.

Discussion of Results.

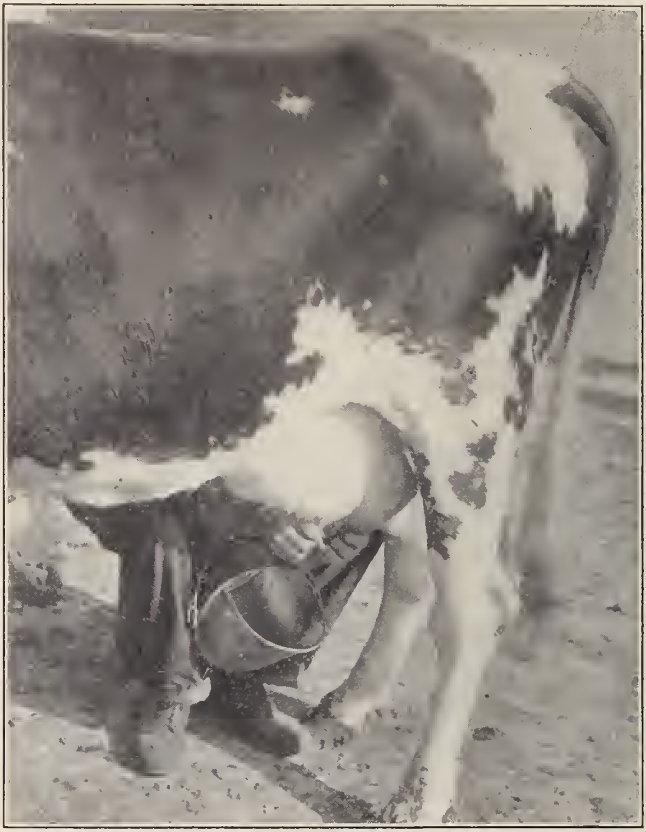
Milk as secreted in the udder of a healthy cow is probably germ-free, but as it is drawn from the udder it is seldom so. The bacteria work their way up into the duct in the teat, and there multiply very rapidly. The first few streams of milk coming out through this same duct probably washes out a large number of these organisms. It would seem desirable to keep these out of the main bulk of the milk, which can be very easily done by collecting the first few streams of milk in a separate receptacle. Many of these bacteria are apt to be organisms from the feces, and they cause very undesirable or injurious changes in the milk. Therefore, this practice seems to be very advisable, because by so doing, we minimize the effect of the first source of contamination.

Figure 2.—Osborn's Clean-milk Pail in Use.



Some of the disadvantages of the use of this pail have been mentioned in another section of this publication. In addition to the difficulty of using this type of pail—and it is difficult to use even after considerable practice—the several separate and rather complicated parts makes it a hard pail to keep properly cleaned, and its use on certain cows is practically impossible, therefore, it seems that a type of pail as was used under Condition No. 4 would be much easier to clean, simplier to use and answers the purpose more satisfactorily.

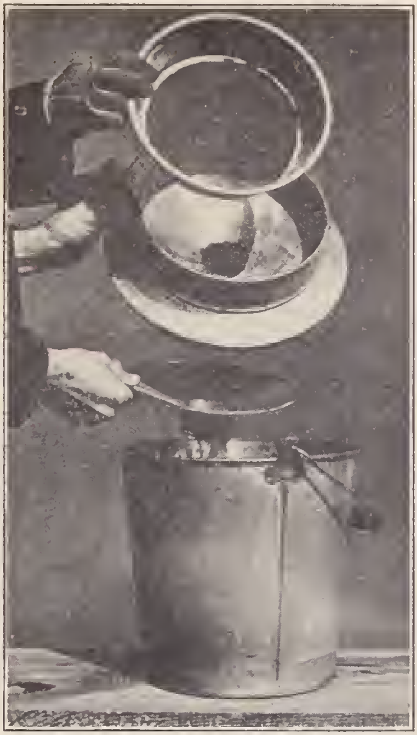
Figure 3.—The wrong way to hold the coal-hod type of pail.



This pail would not give the best results if used in this manner. It should be held upright, between the feet or knees a little distance back from cow, and the streams of milk directed into the pail. An inspector for the Baltimore City Board of Health states that "many farmers are using this type of pail throughout the State, and they express their opinion by saying, 'the open pail is out of their dairy forever.'" In recommending this pail, it is the type not the particular make of pail that the writer wishes to advise the use of. A slanting hood similar to the one on this pail can be put on to the ordinary open pail by any tinsmith at a very low cost.

The Johnson's Anti-dirt Pail has been sufficiently discussed, and the use of any type of pail where the milk is drawn directly upon a flat strainer, of either cloth or wire, is to be discouraged. This particular pail has so many parts to keep clean that the time factor alone in cleaning, makes its use undesirable.

Figure 4.—Separate parts of Johnson's Anti-dirt Pail.



The whole object of modifying the open type of pail is to prevent as far as possible, the entrance to the milk of bacteria from the air, or those that are dislodged from the animal, due to the operation of milking. A possible way to reduce contamination from this latter source would be wiping the udders, teats, etc., with a damp cloth. This serves its purpose very well, but before a cow is milked, the surface of the udder may have dried again, and the remaining dust be dislodged during the milking. Water is likely to cause the cow's teats to chap, especially in cold weather. Such materials as glycerine, sweet oil or vaseline are even more satisfactory than water, because they keep the teats and udder in better condition, also serves the purpose that the filthy practice of moistening the hands with milk does, for those who claim they can not milk with dry hands. A glance at the averages in Tables 2, 3, 4 or 5 will show that it has quite a pronounced effect upon the bacterial content of the milk. In cases where a cow's udder, teats and flank are very dirty, it is advisable to clean with a brush or damp cloth before applying any of the above mentioned materials.

The following tables give the number of bacteria per cubic centimeter of milk as obtained by the combination of the various methods as set forth in the foregoing part of this bulletin which gave the lowest counts; and with the addition of one new condition, namely, clipping the udder, belly, flanks and side of cow nearest the milker. A cow in each of closed and open stables was used for this purpose.

Table 6. Counts on the milk obtained by condition 1 previous to clipping.

Open Stable		Closed Stable	
Cow No. 154	Count	Cow No. 129	Count
	41500		6250
	27500		8600
	36500		46500
	14600		8400
	2950		2900
	6500		4000
	4500		31000
	4500		15250
	18500		5100
	4500		2200
			10150
			10450
			3150
Total	161400	Total	153950
Average	16140	Average	11842

From other figures in this bulletin, and Bulletin No. 177 of this Station, using method 1, Cow No. 129 gave as an average 8618, and 10764 bacteria per cubic centimeter. Cow No. 154 gave as an average 22,769 bacteria per c. c.

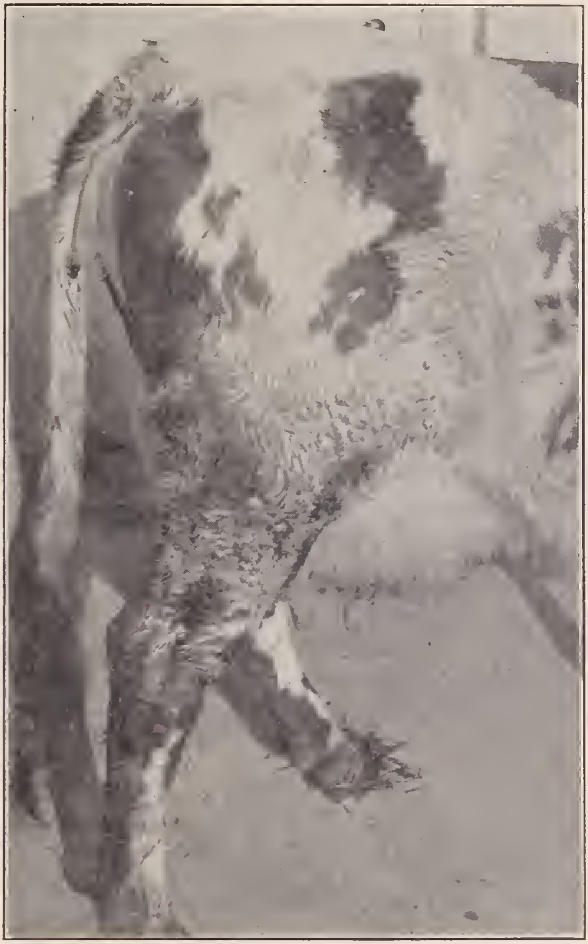
Table 7. Condition E. Same as condition 1, except cow was clipped.

Open Stable		Closed Stable	
Cow No. 154	Count	Cow No. 129	Count
	15050		4400
	2050		1100
	2600		11500
	1150		600
	1050		16600
Total	21900	Total	34200
Average	4380	Average	6840

A very striking difference in the averages is noted under this condition. The average in one case being reduced nearly two-thirds of that obtained by use of Condition 1. As the matter of the advisability of clipping the udder, flanks, etc., of the part of the cow nearest the milker, still seems to be the subject of a little controversy; and this condition alone was not tested many times, too much stress will not be laid on the above figures. However, it does seem that as a labor-saving device, clipping is desirable, as it takes about one-half the

Figure 5.—What one-half hour's labor by two men can do for a dirty cow.

Before clipping.



time to keep a cow cleaned after clipping her, that it required before. It also makes cleaner milking possible, especially with long-haired short-teated cows. The milkers, after milking the test cows, decided that from their standpoint of ease, and speed in cleaning and milking, clipping was desirable. As a result, the entire Station herd was clipped.

After clipping.

It required one-half hour for two men with brushes, curry combs and a power clipper, to transform this cow from an unsanitary, to more nearly a sanitary condition. It takes less time now per day to keep her clean than it did before to keep her dirty.

Table 8. Counts obtained by a combination of conditions 2, 4-D. & E.

Closed Stable		Open Stable	
Cow No. 129	Count	Cow No. 154	Count
	7950		1200
	3900		950
	4200		1450
	2650		1300
	1300		400
	6000		700
	5600		3850
	7400		2600
	1600		1200
	2100		1650
	1950		3300
			500
			700
			500
			1500
Total	44650	Total	22500
Average	4059	Average	1400

These cows were milked by different milkers, and one was in the closed, and the other in the open stable (See Bulletin No. 177, this Station). The milker of Cow No. 129 did not consider these modifications very important, and, therefore, it was rather difficult to get him to milk with any great degree of care. Nevertheless, the average in this case is very much lower than for the same cow a few weeks before, using only Condition 1. The milker in the open stable paid more attention to instructions, with the remarkable result of an average of but 1400 bacteria per c. c. of milk.

CONCLUSIONS.

From the data at hand, it seems fairly safe to conclude that certain practices which can be easily, and cheaply followed out by any dairyman, have a beneficial effect on keeping down or reducing the bacterial count in milk.

1. The results of these experiments, and the desirability of eliminating as many bacteria as possible, would indicate that the practice of separating the first few streams of fore-milk from the main bulk of the milk, is a desirable practice to follow.
2. The Osborn's type of pail did not prove satisfactory, either from the standpoint of bacteria reduction, or ease of use.

3. All kind of pails, having a flat strainer on to which the milk is drawn, of which the Johnson's Anti-dirt Pail is a type, are not to be recommended.

4. The use of glycerine, sweet oil or vaseline as a wash for udder, teats and flanks of cows, decidedly reduces the number of bacteria getting into the milk, when compared with water alone as a wash. Other advantages also noted in this publication.

5. Clipping the udder, flanks, etc., of the cow seemed to reduce the number of bacteria gaining entrance to the milk. Also from the standpoint of ease of cleaning and milking the cow, it is to be recommended.

6. The combination of a few simple and cheap modifications of the ordinary methods of milking resulted in the lowering of the average number of bacteria in the milk. In one case, to about one-third, in the other, to about one-tenth of the number found before these methods were applied.

ACKNOWLEDGMENTS.

The writer wishes to take this opportunity to express his appreciation of the advice and the many valuable sugestions received from Dr. B. M. Bolton, of this Station, during the course of this work. The writer also wishes to thank Messrs. R. H. Waite and W. R. Ballard for their kindness in taking the photographs contained in this publication.

THE MARYLAND AGRICULTURAL
EXPERIMENT STATION

BULLETIN 182. APRIL, 1914.

EXPERIMENTS WITH SMALL FRUITS.

By W. R. Ballard.

Introduction.

The experimental work with small fruits has been limited mostly to tests of varieties. Unsuitable soil and climate for some of the bush fruits has made it extremely difficult to get good uniform set of plants for careful experimental work. However, the general observations which have been made from time to time may prove of considerable value. The one fact which stands out most clearly is that success with any crop is dependent upon choosing for that crop the conditions to which it is best adapted. The experience of most growers proves that in a general way it is easier to suit the crop to the particular conditions than to change the conditions to suit the crop. Indeed, many of the notable successes have been due almost entirely to the acuteness of the grower in settling upon the crop best suited to his soil and climate. While this is true in general it by no means follows that one one should not attempt to change conditions, for within certain limits this can be done, and with considerable profit. The fact remains, however, that one must be under a serious handicap if compelled to compete commercially in the markets with sections where conditions are better adapted to the production of the crop. For local markets and for home use these considerations are of less weight, for one can well afford a little extra care and expense to provide the housewife with fresh fruit from the garden.

Variety Tests.

The soil of the plots upon which the bush fruits have been grown is a heavy clay loam, most of which is well underdrained. It has had thorough culture and is in a good state of fertility. The hot sun, drouth and various plant diseases have been very detrimental to the growth of many of the varieties and the number which have been able to withstand these untoward conditions successfully are rather few. Late frosts have occasionally injured the crops very materially. Records of comparative yields have varied to such an extent as to make their value problematical so that the results of much of this work resolves itself into a simple statement of what was done.

Black Raspberries.

All the varieties of black caps have suffered a great deal from the hot sun. They have been much subject to crown gall and anthracnose, and on the whole seem less adapted to a warm climate than most other bush fruits. The yields have been meager and generally unsatisfactory. Black Diamond, Kansas and Munger have succeeded probably as well as any others. The following varieties have been tried:

Black Diamond,
Conrath,
Cumberland,
Eureka,
Gregg,
Kansas,
Munger,
Ohio,
Older,
Palmer,
Souhegan.

Red Raspberries.

The red varieties have succeeded better than the black caps. The fruit, while too soft for shipping, is quite desirable for dessert purposes. They are subject to crown gall and other diseases, but seem better able to withstand the hot sun. The following sorts have been tested.

Cuthbert.—Fruit is good size, moderately firm, sweet and rather good in quality.

Eaton.—Large size, inclined to crumble, moderately juicy, not productive.

Golden Queen.—This is the best of the yellow sorts, fruit is juicy, soft and fairly good in quality.

King.—Medium size, firm, mild and only fair in quality.

Loudoun.—Fruit good size, moderately firm, pleasing subacid, fair quality.

Marlboro.—Good size, vigorous, productive.

Miller.—Good size, fair quality.

Thompsons Early.—Matures early, fruit medium size, soft and fairly good in quality.

St. Regis.—Fruit good size, moderately firm, juicy, fair quality. This gives a moderately good second crop in the fall in favorable seasons.

Herbert.—Good size, moderately firm, fair quality.

New Brilliant.—Medium size, rather firm, juicy, watery, quality not high, vigorous and productive.

Shipper's Pride.—Medium to above, moderately firm, juicy, fair quality, productive.

Manitou.—Medium size, dull red color, moderately firm, juicy, sweet, good, vigorous and productive.

Thwack.—Good size, moderately firm, rather dry, not high quality.

PURPLE CANE RASPBERRIES.

As a rule the purple cane types are very vigorous and productive. The fruit is large, rather dull in color and is more acid than either the black or red sorts. Of the few varieties tested here the Cardinal has been the most satisfactory. Haymaker is productive and of good size, but seems to be quite subject to anthracnose. Columbian has given fairly good yields.

MATTED ROW VERSUS HILLS.

In 1907 a new planting of raspberries was made and one-half of the plot was planted in matted rows the other half in hills. The following table gives the yields per plot of the different varieties for two seasons and the average yield per acre.

YIELDS OF RASPBERRIES IN QUARTS.

VARIETIES	Matted row			Hills		
	qts. per plot 1908	qts. per plot 1909	qts. per acre, average for 2 years	qts. per plot 1908	qts. per plot 1909	qts. per acre, average for 2 years
Haymaker	14	9¾	2586	15½	8¾	2640
Gregg	1¾	3	507	¾	¾	163
Munger	4½	6⅞	1129	½	1¼	190
Eureka	3	5½	925	1¼	⅞	231
Ohio	¼	2⅓	273	¼	¼	54
Older	5¾	4⅓	1097	1¼	1⅓	273
Palmer	1¼	1⅓	273	¼	1/16	33
Kansas	½	1⅛	353	1	1½	271
Cumberland	11¾	9½	2313	4½	2	706
Columbian	8¾	17½	2858	10	9⅛	2232
Black Diamond	7¼	8	1660	3½	3	706
Souhegan	8	7	1633	2¾	2⅓	543
Cardinal	24	26	5445	13½	11⅔	2626
King	¾	5⅓	661	1	1½	271
Thompson Early	3¼	3⅓	710	2¾	2⅛	530
Miller	4	1⅔	617	1½	2½	435
Marlboro	.	4⅓	943	½	4	490
Eaton	¾	4⅓	543	½	3¾	462
Golden Queen	3¼	4⅔	651	¾	3⅔	476
Cuthbert	2	1¾	407	½	1½	217
Average of all varieties			1279			677

The yields of most varieties were so low that it is difficult to draw any conclusions of value, but under the conditions as they existed here it would seem to be more desirable to plant in a matted row than in hills.

BLACKBERRIES.

The first planting of blackberries was made in 1903, and included the following varieties:

Kittatiny,
Taylor,
Ancient Briton,
Ohmer,
Iceberg,
Early Harvest,
Wilson, Jr.,
Wilson Express,
Lucretia,
Illinois,
Minnewaski,
Wasachusetts,
Early King,
Agawam,
Eldorado,
Snyder,
Erie,
Rathbun,
Lawton.

The following year there was a heavy crop on Ancient Briton and a fair crop of good berries on Eldorado. The double blossom disease appeared shortly after this and practically ruined the plantation. The fact that Early Harvest and Iceberg continued to fruit until 1910 may indicate more resistance to disease than others.

In 1912 a new plantation was started which included the following varieties:

YIELDS OF BLACKBERRIES, 1913.

	Quarts per Acre.		*Quarts per Acre.*
Governor	321	Mercereau	1,261
Wasachusetts	2,001	Early Harvest	522
Minnesota King	1,479	Agawam	2,784
Taylor	495	Erie	——
Robinson	843	Minnewaski	783
Lawton	1,974	Western Triumph	2,687
Stones Hardy	2,784	Perfection	234
Ohmer	522	Ward	——
Himalaya	——	Early King	——
Blowers	348	La Grange	129
Ancient Briton	87		

DEWBERRY.

Lucretia,
Austin,
Gardena,
Everbearing,
Mammoth,
Premo,
Sugar Plum.

The following year there was an unusually heavy bloom on all varieties, but the frost May 11 killed so many blossoms that only a fair crop was picked. The table above gives the yield of a few varieties calculated per acre. The plants have made a good growth and give promise of an abundant crop this season.

GOOSEBERRIES.

In 1903 a number of varieties of gooseberries were planted on a plot of good garden soil, and a few more varieties were added in 1907. Plants were set 5x5 feet and cultivated both ways. Most varieties have been subject to leaf diseases to such an extent that foliage has usually dropped early in the summer. Late frosts have destroyed some crops, but on the whole the yields have been fairly satisfactory. The following table gives the yields calculated per acre for the years 1907-1912, and the average for the six years.

YIELDS OF GOOSEBERRIES.

VARIETIES	Quarts per Acre						
	1907	1908	1909	1910	1911	1912	Average
Industry	870	1742	....	172	....	....	928
Downing	3047	2177	870	1305	1742	....	1828
Houghton	6096	5661	1305	3919	3484	....	4093
Triumph	2177	3919	870	2612	2612	2322	2418
Golden Prolific	435	870	348	290	580	870	565
Red Jacket	2612	435	1305	870	290	870	1063
Columbia	1305	5226	870	3919	2177	6968	3410
Chautauqua	870	3484	1742	3483	2177	3047	2466
Pearl	2612	4354	870	3484	2177	2612	2684
Mountain	....	1742	....	172	870	870	913
White Smith	....	1742	435	580	580	1742	1015
Crackerjack	....	1742	249	870	1305	2177	1268
Keepsake	....	....	174	870	870	870	696
Crown Bob	....	....	87	87	72	....	82

The English varieties Industry and Crown Bob have given very poor results. The plants are less vigorous and less productive than the American sorts. Some of the large fruited American varieties have yielded comparatively well, Columbia and Triumph being the most satisfactory. They have sold on the local markets for ten cents a quart, the smaller kinds bringing seven and eight cents.

CURRANTS.

The following varieties of currants have been tested:

Red.

Fay Prolific.
Versailles.
Red Dutch.
Moore Ruby.
Wilder.
North Star.
Pomona.
Victoria.
Perfection.
Prince Albert.
London Market.
Cherry.
Red Cross.

White.

White Transparent.
White Dutch.
White Imperial.
White Grape.

Black.

Lee Prolific.

The cane blight has been very destructive and many of the plants have died. There seems to be some difference in varieties in regard to their susceptibility to this disease as indicated by the number of plants remaining in the plots. Only one plant of Red Dutch is missing and Prince Albert is next. The yields as a rule have been low, but the demand for the fruit has been good with the price ranging around ten cents per quart. The varieties which have been most productive arranged in order of yield are Red Dutch, North Star, White Grape, White Transparent, Red Cross, Pomona and London Market.

FERTILIZER TESTS.

In the spring of 1910 plots were laid off across the varieties of gooseberries and currants and fertilizer applied as follows: Plot 1 received a top dressing of pig manure at the rate of twenty tons per acre, plot 2 received a mixture of commercial fertilizer approximating the value of plant food in the manure and consisted of 400 pounds nitrate of soda, 150 pounds of sulphate of ammonia, 200 pounds of nitrate of potash, 100 pounds of kainit and 600 pounds of dissolved phosphate rock. Plot 3 was left as a check. Because of late frosts it has been possible to get only one year's record of yields. These are given in the accompanying table. In growth of plant as well as in yield the response to this fertilizing has been immediate and rather marked, and it is unfortunate that this work could not be carried on under more suitable conditions and more definite conclusions reached.

Varieties	Manure		Fertilizer		Check	
	qts. per plant	qts. per acre	qts. per plant	qts. per acre	qts. per plant	qts. per acre
Pearl	2½	5445	2¼	4900	½	1090
Downing	4	8712	2	4356	½	1090
Houghton	6¼	13612	5	10890	2	4356
Triumph	2	4356	1⅔	3630	½	1090
Chautauqua	½	1090	1	2178	½	1090
Average for goosberries		6643		4688		1643
Red Dutch	2	4356	2	4356	1	2178
White Grape	1½	3268	1	2178	1½	3268
North Star	1¼	2722	2	4356	½	1090
Average for currants		3448		3630		2178

GRAPES.

For a number of years the culture of grapes has been given some consideration at this station, but little in the way of experimental work was attempted. Very few accurate records were kept, owing to frequent depredations. The vineyard was located on a gravelly side hill which in many ways was an ideal location. Most of this vineyard having had to be removed on account of building operations, it was thought advisable to record here what little of value could be gleaned from the meager records, with the hope that the new vineyard which will soon be in bearing might yield results of greater value.

TRAINING EXPERIMENTS.

In the spring of 1903 twenty-five vines each of Concord, Moore Early, Worden, Woodruff Red and Niagara were planted in order to test out the following methods of training: (1) Munson, (2) one-wire Kniffin, (3) two-wire Kniffin, (4) three-wire Kniffin and (5) the fan system. Considerable difficulty was experienced with the Kniffin systems in getting strong canes to grow at the proper points of renewal. This was especially true of the lower arms. The fan system has somewhat the advantage in this respect. Accurate records of yields could not be secured, but in general, the most fruit was produced on the fan and Munson systems. This, however, is only preliminary, and more attention will be given to this point in the future.

VARIETIES.

Besides the varieties in the training test, a number of other varieties were added in 1904. Several standard sorts were planted, together with several of Munson's hybrids. Many of the Munson hybrids were very vigorous growers and productive. Some of them require a long season in which to develop their flavor, coloring up sometimes a long time before fully mature, and while the flavor in some cases was very good, there did not seem to be among them any serious rival to the commercial sorts already grown in this State. Some varieties might prove of value for the manufacture of grape juice, and although only a preliminary test was made, the variety America gave considerable promise in this regard.

Mr. T. V. Munson, of Denison, Texas, after having found it impossible to succeed with the Labrusca varieties such as Concord, turned his attention to the grapes which were native to that section and hybridized many of them with the cultivated varieties. The wild "Post Oak" grape was found of great value in this work and many of the hybrids which he later introduced contained blood from this species. It was with the view of testing such hybrids in comparison with the common cultivated kinds that these varieties were planted in the station vineyard. The following list gives the varieties tried:

McPike,
Goethe,
Lindley,
Early Daisy,
Mo. Reisling,
Lucille,
Green Early,
Campbell,
Green Mountain,
Delaware,
Moore Diamond,
Agawam,
La Salle,
Male Muscadine,
San Jacinto,
Rogers No. 4,
Stark Star,
Salem,
Hicks,
Mericadel,
Carmen,
Cloeta,
Hermann Jaeger,
Amerbonte,
Xenia,
Munson,
Captain,
Brilliant,
Amethyst,
Muench,
Blondin,
Kiowa,
Presly,
Headlight,
R. W. Munson,
Big Extra,
Delago,
Bailey,
Rommel,
Valhallah,
Uriel,
Laussel,
Manito,
Marguerite,
Shala,
America,
Tonkawa,
Wine King,
Lukfata,
Fern Munson,
Gold Coin,
Albana,
Atoka,
Beacon,
Wapanuka,
Hidalgo,
Husmann,
Wetumka.

THE CULTURE OF SMALL FRUITS.

Black Raspberries.

Commercial Plantings.

From a commercial standpoint the black cap raspberries are of far more importance than the red and purple types. The latter, ripening over a longer period, are more expensive to harvest and the fruit is too soft to stand shipment well. They are, therefore, better adapted for the home garden and for local markets. The black raspberries require a cool climate for their best development, the heat of summer being more injurious than the cold of winter. Recent reports indicate that the acreage in the warmer section is decreasing more or less rapidly due to diseases and other troubles, and the probabilities are that as a commercial proposition the crop will gradually gravitate toward the cooler sections of the State. As will be seen by the following table compiled from the 1910 census report, the largest acreages are found in Washington and Anne Arundel Counties:

State	846 Acres.
Washington County........	392 Acres.
Anne Arundel County......	144 Acres.
Frederick County..........	60 Acres.
Wicomico County..........	48 Acres.
Caroline County............	46 Acres.
Prince George's County....	43 Acres.

Undoubtedly the greater percentage of this acreage is devoted to the black caps.

This should prove a helpful guide to anyone who is contemplating engaging in this industry on a commercial scale. The fact that the industry is developed in certain sections not only indicates conditions suitable to their production, but is also more likely to insure transportation facilities, labor and buyers. The varieties adapted to the conditions and the methods of culture and handling have already been worked out so that one need make no costly experiments in determining these things for himself.

Site.

Good air drainage as a protection from late frosts is as important as soil drainage, and most of the successful plantings in Western Maryland are found on the mountain slopes or on moderately rolling land. As a rule a northern exposure offers better protection from the heat of summer, but this is not always necessary.

Soil.

Raspberries need moderately fertile soil, although the poorer soils may be made available by proper fertilization. On the mountain slopes of Western Maryland the free stone soil and slate ridges are preferred. While not in a high state of culture, these soils respond readily to manure and fertilizer and produce good crops of large berries. In general a sandy or clay loam which will produce good crops of corn and potatoes will give profitable returns. Proper under drainage is essential. Soil should have good texture and should contain abundant supply of decaying vegetable matter. The soil must be retentive of moisture or fruit will suffer in dry weather. One of the surest ways of securing this is by keeping plenty of humus in the soil. Humus takes up water readily and gives it up slowly. Plowing down green crops, the addition of manure, and thorough cultivation all help to solve the moisture problem.

Fertilizers.

Black raspberries require heavier feeding than do the red types, and stable manure seems to be the most popular form of plant food used. Many growers use wood ashes to advantage. Card suggests the use of about 50 pounds nitrate of soda, 150 pounds of acid phosphate and 50 pounds muriate of potash. Since humus is such an important factor it is advisable to get nitrogen by growing leguminous crops before planting and cover crops after. Cultivation is very important in aerating the soil and unlocking plant food. Black raspberries appear to thrive on acid soils.

Cultivation.

Cultivation should begin early and be kept going until about the first of August when a cover crop of crimson clover may be sown. Some growers use the bar-share plow in the first cultivation, gradually working soil back to plants with double shovel. In commercial patches, the plants are set so as to allow working both ways. This allows the work to be done mostly with the cultivator and limits the amount of expensive hand labor.

Propagation.

The black raspberries are propagated principally from tips. Under natural conditions the tips root readily, but in cultivated patches it is necessary to cover the tips with soil for best results. A good method is to stick the end of the branch into a hole made with a spade and then force the earth back against it. Young plants root more readily than do older ones.

Planting.

Commercial growers plant in hills from five to six feet apart each way. This makes cultivation easier. This will require from 1,200 to 1,700 plants per acre. When grown in rows, plants should be set three feet apart in rows with rows six feet part, thus requiring about 2,400 plants per acre. The distance apart to plant will depend somewhat upon the variety and the fertility of the soil. Plants should be set early in spring in well-prepared land. Prune plants back well when set so as to get as much growth as possible the first year. Growers find it advisable to renew the plantations after three or four crops are harvested, as young plants are more vigorous and productive than older plants.

PRUNING.

Besides the pruning done at planting time, it is necessary to pinch back the new shoots during the summer. This is usually done just before the picking season. The height at which this is done varies with growers at from one to two feet. It is necessary in order to get all the canes tipped at the required height to go over the patch two or three times. This makes a short stocky, well-branched plant. The number of canes to be left should be limited to from three to six, three probably being better than a greater number. Immediately after the picking season, the old fruiting canes are cut out and burned. This allows all of the strength of the plant to go into the new canes and helps also very materially in destroying diseases such as anthracnose. In the fall or spring the canes are tied to stakes. The fruiting branches should be cut back in spring to from twelve to eighteen inches in length.

HARVESTING.

In this State picking is done mostly by hand, women and children doing a great deal of this work. Black caps require fewer pickings than the red types, consequently are harvested at less expense. Pickers get from one and one-half to two cents a quart. The difficulty of securing pickers limits somewhat the production of this crop. Yields vary greatly, but would probably average 2,500 quarts per acre.

MARKETING.

Black caps are marketed in the quart box and shipped in the thirty-two quart crate. These net about $1.80 to $1.90 per crate. Local markets require large quantities and many carloads are shipped annually to Baltimore and Pittsburg.

In Western Maryland this is considered one of the most profitable crops and many of the growers have bank accounts and retire to the cities for the winter.

VARIETIES.

The popular varieties for commercial planting are Kansas, Munger, Cumberland and Black Diamond. Some growers claim that Kansas is the best money maker, while others say that Munger holds up longer and is a sweeter and much better berry. These varieties are equally valuable for home use. Every home garden should include a few plants and in the warmer sections they should be so placed as to be shaded from the hot afternoon sun. A mulch of straw or coarse manure for the home patch is sometimes helpful in attaining success.

Red Raspberries.

Site.

The purple cane raspberries are included with the red raspberries, although they are hybrids between the red and the black. In habit of growth and method of propagation some varieties resemble more the black caps. As a rule they are strong, vigorous growers. On account of the soft texture of the fruit this group is grown mostly for home use and local market. They seem to stand the heat of summer better than does the black type, yet even with them the largest and best fruit is produced in a cool climate. A northern exposure will be found of distinct advantage.

Soil.

A sandy loam, especially if it contains plenty of decaying vegetable matter, furnishes a suitable soil for this crop. They should be given thorough culture as with other small fruits. The growth of canes should not be stimulated too much by heavy feeding.

Propagation.

Most varieties sucker freely and the cultivator must be used to keep the rows within bounds. Suckers may be used to start a new plantation, but care must be used in removing them to get some fibrous roots on each division. Sometimes this can be done to advantage early in summer by taking the young shoots while quite small as they soon become well established and make a vigorous growth.

Planting.

When planted in rows they should be placed about three feet apart in the row with rows six feet apart. On account of the freedom with which suckers are produced it is probably easier to keep them in shape by planting in hills five feet apart each way and keeping the cultivator going to reduce the number of suckers. If it is preferred to grow them in rows the weak canes should be cut out.

Pruning.

Opinions vary as to the advisability of tipping the shoots in summer, but it is probably better not to tip them unless the growth is very strong. It is, however, very important to remove the old fruiting canes and to thin out the new shoots leaving only from three to six of the strongest canes. These should be headed back in spring from two to four feet, depending upon the method of handling. Where they are to be staked the canes may be left longer than otherwise.

HARVESTING.

The red raspberries should be picked every other day as they deteriorate rapidly when ripe. They should be placed upon the market as soon as possible after being picked. Care should be taken not to pick while berries are wet. Most varieties ripen over a long season, thus requiring a number of pickings to secure the crop. This characteristic makes them of special value for home use.

MARKETING.

On account of their soft texture they should always be handled in the pint box. There is usually a good demand on local markets with an insufficient supply. The yield is not as large as with the black caps and should command two cents more per quart. They are primarily a dessert fruit and the fresher they are used the better.

VARIETIES.

Of the purple types Cardinal, Columbian, Haymaker and Shaffer are probably the most important. Cuthbert is one of the very best of the reds. Thompson Early has been the earliest one to fruit on the Experiment Station ground. Loudon, Marlboro and Miller are well spoken of in various sections. The new St. Regis everbearing seems to be a very promising new sort. It gives in addition to the regular crop, a fair yield during the cool weather in fall.

RASPBERRY DISEASES.

Crown Gall.—This is a disease affecting the stem near the ground and also the roots of raspberries, causing knotty swellings which interfere with the growth of the plants.

Treatment.—Plant only healthy stock.

Anthracnose.—This disease appears as spots on the canes and leaves. It also attacks the fruit causing it to dry up. This is one of the most destructive diseases with which raspberry growers have to contend.

Treatment.—Cutting out the diseased canes immediately after the picking season and burning the brush seems to be the most effective means of controlling the anthracnose.

Blackberries and Dewberries.

For home use blackberries and dewberries may be grown in almost every section of the State, but as a commercial industry certain sections seem to be better adapted than others. The following table will show where the greatest development has taken place.

The State	1,180 Acres.
Wicomico County	355 Acres.
Caroline County	302 Acres.
Anne Arundel County	269 Acres.

On the whole there are probably more acres in dewberries than in blackberries and the new plantings are mostly dewberries. These crops seem better able to withstand the heat of summer than do most other bush fruits. There is usually a good demand for the fruit, but production is sometimes uncertain on account of late frosts and dry weather. In general, however, returns are quite satisfactory and many growers find these crops very profitable.

Soils.

A strong well-drained clay loam makes a very suitable soil for blackberries, although lighter soils if full of plant food and well cultivated will give excellent results. Abnormal growth is to be avoided as it requires greater labor to keep plants within bounds and production is likely to be more or less curtailed. The soil should be retentive of moisture or berries will suffer in dry seasons. The supply of humus must be kept up, and in most dry sections a dust mulch will be found advisable. In some sections, especially for small plantings, a mulch of coarse stable manure or other material is very beneficial.

Dewberries require for their best development a light sandy soil. It should be kept sufficiently fertile to get a moderate growth of vine. Heavy clay soils are entirely unsuited to this crop.

Propagation.

Blackberries are propagated by suckers or by root cuttings. The best plants are obtained from root cuttings. The roots are dug in the fall, cut in pieces an inch or two in length, and stored until spring. They are best started by placing in sand in a hotbed to sprout and later set in the field. Dewberries are grown mostly from tips as they root quite readily. Layers and root cuttings may also be used.

Planting.

Plants may be set either in late fall or early spring. Spring planting is to be preferred if it can be done in good season. Blackberries may be grown either in hills or in rows. They should be planted seven or eight feet apart for hills and eight by three for rows. The question as to which method gives the best yields is a debatable one and depends very largely upon local conditions. Cultivation in both directions has the advantage of keeping weeds and suckers down with the minimum of hand labor, and where help is scarce this is an important factor. Dewberries should be planted four feet apart where stakes are used and about six by three feet for trellis.

PRUNING.

The best time to remove the fruiting canes is just after picking season. The brush should be removed and burned to destroy disease and insects. Unless a trellis is used, the simplest method of pruning the blackberry is to tip the new shoots in summer when they are eighteen inches to two feet in height. This will produce short, stocky, well-branched plants which do not require staking. Be sure to do this work before the canes get higher than two feet. If delayed the plants will become top heavy and fall over, and the summer pruning will have done as much damage as good. In spring the branches should be shortened somewhat, but care should be exercised so as not to cut off two many fruit buds. It is probably best to delay this work until the buds are well started, so that one can better judge how far back to cut. All weak canes should be removed. All the pruning that is necessary for dewberries is to cut back the canes when they are tied up in the spring (see Fig. 1). The new canes are allowed to sprawl on the ground until ready to be tied up to stakes.

HARVESTING.

Dewberries ripen much earlier than the blackberries and are consequently in better demand. For home use and local markets they should be allowed to ripen well before being picked. For shipment, however, they may be picked as soon as they get their color. They should not be long exposed to the sun as they scald very easily. Blackberries are the heaviest yielders, averaging 3,000 or more quarts to the acre. The fruit is usually marketed in the quart basket which nets from seven to ten cents.

VARIETIES.

Lucretia is the standard variety of dewberries. There seems to be two types of this variety, one of which is quite worthless. In recent years Austin's has been planted quite extensively. This is similar to Lucretia, but is about a week earlier.

Of the blackberries Early Harvest is very popular and profitable on account of its earliness. Berries are only medium in size, but are produced in large quantities. Snyder is one of the hardiest and is grown to quite an extent. Other good varieties are Mercereau, Eldorado, Blowers, Ward and Rathbun.

The Himalaya, which has been extensively advertised, is a vigorous growing variety, sometimes making canes thirty or forty feet long and rooting at the tips. Some few growers have had fair results with this variety when grown on a trellis, but from general reports it is not likely to prove of much value.

BLACKBERRY DISEASES.

Rust.—This in its most noticeable form appears as a reddish orange coating on the under side of the leaves. It does not occur very extensively, although some varieties are more susceptible than others.

Treatment.—Dig out affected plants and burn.

Double-Blossom.—This disease has been very troublesome on some varieties, often ruining entire fields.

Treatment.—No effective means of control has yet been worked out.

CURRANTS.

SITE.

Currants are grown only in a small way in Maryland and there does not appear to be any prospect of their assuming commercial importance in the near future. There is a healthy demand for what few are produced, the cooler sections of the State might profitably enlarge on this crop, but blight and injury from heat is so prevalent in the warmer sections that success is extremely uncertain. A northern exposure and soil which is retentive of moisture should be selected whenever possible.

SOIL.

A cool, moist clay loam, well underdrained is more suitable for this crop than the lighter sandy soils. The currant responds readily to heavy feeding and manure should be supplied in liberal quantities. Wood ashes are beneficial. Where such material is not available commercial fertilizers may be substituted. Potash and phosphoric acid are important, nitrogen may be supplied by growing leguminous cover crops. Lack of plant food is one of the most common causes of failure with this crop.

PROPAGATION.

Currants are usually propagated by hardwood cuttings. Well-ripened shoots of one season's growth should be cut in fall when wood has fully matured. These should be tied up in bundles and buried upside down in a well-drained situation and planted in nursery row early in spring. If preferred, cuttings may be set in nursery in the fall immediately after being cut. Most varieties root readily.

PLANTING.

Unless planting can be done very early in spring, fall planting is preferable as the currant pushes its buds earlier than most bush fruits. The ground should be heavily manured in fall, plowed deeply and the soil should be thoroughly prepared before plants are set. Rows six feet apart and plants four feet in the row is about the right distance. Some prefer five feet each way. This allows cultivation in both directions. Cultivation should be thorough but not deep.

PICKING AND MARKETING.

Currants are used principally for making jelly. They are too tart for eating fresh, although when allowed to ripen thoroughly are quite palatable. Picking should not be done while berries are wet. The entire cluster should be removed without pulling berries from stems. Berries quickly spoil if crushed or bruised in any way. For shipping the fruit may be picked a little green. Quart baskets or the common grape basket may be used.

VARIETIES.

Of the red varieties, Red Dutch, Cherry, Fays Prolific, Wilder, Pomona, Red Cross and Perfection may be planted. White Grape, White Imperial and White Dutch are white varieties. As a rule the white varieties are milder in flavor than the red sorts. The black varieties have not assumed much importance in this country, although a few of the English type are grown. Lee Prolific is one of these which does fairly well. Its pungent flavor is disliked by many.

DISEASES AND INSECTS OF CURRANTS.

Cane Blight.—This is a destructive bacterial disease somewhat similar to the fire blight of the pear and apple.

Treatment.—No effective treatment has been devised.

San Jose Scale.—Much injury to currants often results from the attacks of this pest.

Treatment.—Spray with the lime sulphur solution 1 to 9 during dormant season.

Currant Worm.—See under Gooseberries.

GOOSEBERRIES.

SITE.

Gooseberries are grown more extensively than currants and promise greater results for the average grower. Although they suffer from the hot sun and lose their foliage early in the season from leaf spot, the native types give good returns if well cared for. As with other small fruits a cool climate favors their development. They demand about the same conditions of soil and treatment required for currants. Within recent years the demand for gooseberry juice as a basis for soda fountain preparations has developed and as a result greater attention is being given to this crop.

Soil.

A well-drained clay loam well supplied with humus furnishes a good soil for the gooseberry. A good supply of moisture is important. Sufficient manure or fertilizer should be supplied to keep up a supply of vigorous new canes. Most growers favor cow manure for this crop.

Propagation.

Cuttings do not root quite as readily as do those of the currant, but a fair percentage may be secured by this method. The plan recommended for currants should be followed. For home use suckers or layers will supply a sufficient quantity. On a large scale mound layering is practiced. Plants are cut back severely in fall to stimulate the production of vigorous new shoots. About July 1st these new shoots are mounded up with earth leaving only the tips exposed. About the last of October these shoots are removed and planted or stored for spring planting.

Planting.

Buds start early so that planting must be done as soon as ground can be worked in spring. Otherwise fall planting is advisable. Plants may be set six by four feet or five feet apart each way. Give good cultivation.

Pruning.

Bushes should be kept thinned out and as the best fruit is produced on one-year shoots the wood two or three years of age should be removed. Gooseberries are sometimes trained to tree form, but the bush form is the most desirable for commercial purposes.

Picking and Marketing.

Picking gooseberries is not a very pleasant operation on account of the thorns. Thick leather gloves are necessary to protect the hands. As the berries are usually marketed green they may readily be stripped off with little or no injury to the fruit. Most of the product goes to canneries or for the production of juice. The fruit keeps in good condition for some time and may be shipped long distances in perfect safety. Grape baskets are used extensively for this purpose, as are also the quart baskets. The production of this fruit seldom equals the demand. Yields vary from 200 to 500 bushels per acre and are commonly quoted on the New York market at about $2.00 per bushel. While the ripe fruit has not come into general use, it is really quite palatable, and some of the larger fruiting kinds should be grown for this purpose at least for home use.

VARIETIES.

Downing and Houghton are the great commercial varieties. The latter being the most productive. Pearl resembles Downing considerably. Mountain, one of the new sorts, is quite vigorous and healthy, but seems to be rather thorny. Josselyn, Triumph, Chautauqua and Keepsake are large fruited forms worthy of trial. The large English type can not be grown very successfully in this country on account of the long hot summers. Of these the Industry seems to succeeds as well as any.

DISEASES AND INSECTS OF GOOSEBERRIES.

Leaf Spot.—This disease attacks the foliage, causing it to drop early in the summer, and as a result the growth is greatly checked.

Treatment.—Spray with bordeaux.

Mildew.—This disease attacks the European types to a much greater extent than the American varieties, the latter seldom suffering serious injury.

Treatment.—The application of bordeaux for leaf spot will keep the mildew under control.

Currant Worm.—This small greenish worm appears usually about the latter part of May and rapidly defoliates the bushes. One needs to keep on the lookout for them or their damage will be done before preventive measures can be used.

Treatment.—An application of a teaspoonful of white hellebore to a gallon of water, applied as soon as the worms appear, has been found to be an effective remedy.

GRAPES.

SITE.

Soil and climate in Maryland are well adapted to grape culture and greater interest should be taken in the production of this fine fruit. The demand for grape juice is becoming so great that immense crops will be needed for this purpose alone. It is so easily prepared that many growers are finding it more profitable to sell the juice than to handle the fresh fruit. There is a great opportunity for those in the vicinity of the large cities to grow some of the finer quality varieties for special trade. Many people seem to think that the methods of pruning and training are so complicated that they hesitate to engage in this industry. However, the principles are easily learned and experience will soon give them enough skill to command the situation. Every person with a few feet of ground should have one or more vines for home use. They make excellent arbors and furnish shade as well as fruit. A southern or eastern slope is usually preferred for commercial vineyards.

SOIL.

The grape will grow in a great variety of soils if well drained, but deep sandy and gravelly land is preferred above all others. Ground should be deeply and thoroughly prepared before plants are set. The vineyard is one of the most permanent of plantings so that thorough preparation is essential. Stable manure and bone meal has given good results as a fertilizer. The amounts to be used will depend upon the variety and the fertility of the soil. Weak growers like Delaware will need greater stimulation than the stronger growing sorts.

PROPAGATION.

Grapes are usually propagated from hardwood cuttings of well-matured canes. Cuttings are made with two or three buds, depending upon the length of joints. The bottom cut should be just below a bud. After being tied in bundles, cuttings are packed in sand in a cool cellar and planted out in nursery rows early in spring. Usually it is cheaper and better to get plants from a reliable nurseryman than to try to raise them. Grafting is readily accomplished by either the whip or cleft graft methods. No wax is used, but soil is mounded up to prevent drying. Bench grafting either on cuttings or root stocks is easily accomplished. This may be done at any time during the winter and grafts stored until spring when they are set in the nursery.

PLANTING.

Strong one-year-old plants are best for planting and they should be set in spring when land is in good working condition. The distance apart to plant will depend somewhat upon the variety, but rows ten feet apart and vines eight feet in rows will accommodate most varieties. Strong growers will need more room. Roots should be pruned back to six or eight inches and the top to two strong eyes. Give good culture until about August when crimson clover may be sown as a cover crop.

PRUNING.

All the pruning necessary to do the first year is that done when plants are set and then pinching out all the shoots which start, except the strongest one. The second year this should be cut back to three or four buds. By the third year it ought to be possible to get vine upon the trellis. Pruning from this time on will depend upon the training system adopted. The two things to keep in mind are pruning to limit fruit production to correspond with the strength of the vine and to provide for the production of new fruiting canes for the following year. It should be borne in mind that the fruit is produced on the green shoots coming from the previous years' canes. Each strong bud will produce from two to four bunches of grapes, and as from sixty to seventy-five bunches are sufficient for a moderately strong grower such as Concord, it is a comparatively easy matter to select the proper number of fruiting canes to be left. These should be situated so as to fit the trellis readily and utilize space to the best advantage. Short spurs with one or two strong buds should be left as near the main trunk as possible from which to get the new canes for the following year. Usually the buds farthest from the trunk start first and it is sometimes necessary to pinch these back in order to force the buds on the spurs to start. After this has been done all that is necessary is to remove all other canes which have been produced. As a rule too much bearing wood is left on for the best results in fruit production.

TRAINING SYSTEMS.

There are a number of different systems of training in use, but only a few of the more important types will be discussed. The essential features are convenience for cultivation and spraying, light and space for development of fruit, saving of labor in tying and cheapness of trellis. Any system requires more or less attention for the best results. Probably the simplest plan is to tie fruiting canes to stakes set at each plant, but in general some form of wire trellis will be found advisable.

THE TRELLIS.

Good posts of cedar, locust or other durable woods should be used for the trellis. They should be long enough to stand about six feet high when set. A post should be set between each two plants. The end posts should be heavier than the others and should be thoroughly braced with post and cross wire (see Fig. 2). Galvanized wire should be used. No. 11 makes a good size for general use. Small iron ratchets costing only a nominal sum should be used at the end of the wire to take up the slack. Staples may be used to attach wire to intermediate posts.

THE FAN SYSTEM.

This type is not used at present as much as formerly. It has the advantage of renewing each year near the ground, thus doing away with much of the old wood. As a rule a three-wire trellis is used and from four to six canes are left. These are simply spread somewhat in the form of a fan and tied to trellis. One objection to this system is that much of the fruit is borne too low to develop properly.

Kniffin or High Renewal.

There are various modifications of this system in use, but in the main they are based upon the same principles. Two wires form the trellis and a single trunk is carried directly to the top wire. Two canes are taken out from side spurs at each wire. Each year the vine is renewed from spurs at these points (see Fig. 3). These four canes are tied horizontally along the wires and the new shoots are allowed to hang. No summer tying is required. This system seems to be the most popular at present in the leading grape sections of the East. It is better adapted to the strong growers than to those less vigorous.

The Munson System.

The Munson system has three wires, but instead of being placed one above the other as in the fan system, cross-bars are used to form an overhead canopy. The middle wire should be fastened to posts at a height of four feet. Holes are bored in the intermediate posts and wire run through these so as to center on the posts. Cross-bars should be two by four inches and twenty inches long. These should rest upon the middle wire and be fastened with wire to the posts. Wires should run from the ends of arms to post to act as braces. The two lateral wires should rest in notches near the end of these arms. They may be held in place by wrapping the ends of the brace wires around them. This will bring the outside wires four inches above the middle wire. and about ten inches to the right and left (see Fig. 4). The vine is carried to the middle wire and is renewed each year from this point. Two arms from the right and two from the left are pruned and trained along the lower wire. One tie at the ends of the canes is all that is necessary. The new shoots growing up and over the outside wires hang down and do not require any summer tying. Spurs are always left at the crotch for renewing and it is usually necessary to go through the vineyard just before blooming time with a sharp knife and clip off the ends of the most vigorous shoots in order to force a strong growth from the spurs. Such a trellis is up out of the way of cultivation, allows a free circulation of air, shades the fruit and is a great labor saver.

Picking and Marketing.

To sell well on the market grapes must present an attractive appearance. Care should therefore be used in handling. The bunches should be removed with picking shears and should be handled by the stem to avoid destroying the bloom. They are then carried to the packing shed and after removing all green and defective berries, the bunches are packed neatly in four-pound handle baskets. They should be filled so that some little pressure is necessary to bring the lid down to its proper place. Many growers prefer to bag their grapes because of the especially fine appearance which can be secured in that way. Four-pound manilla paper bags are used and should be put on soon after fruit is set. The top of the bag should be folded over the cane and fastened with a pin. When done early this is almost a complete preventive of black rot. It is not an expensive operation and the results are usually very gratifying.

VARIETIES.

In selecting varieties it is always well to remember that some sorts are nearly self sterile and with most varieties better production will be secured when two or more kinds are planted together to secure cross pollination. Moore Early, Concord, Niagara and Delaware are probably planted in this State more than any others for commercial use. For home use and for local markets there are others which should be profitable. Campbell Early is well spoken of in some quarters for market purposes, although it is not of high quality. Moore Diamond is a white grape of merit which should be grown more.

Winchell (or Green Mountain) is an early white grape which should be planted extensively. Worden is larger and of better quality than Concord, but is not as good a shipper. Eclipse is a new black grape which, judging from reports, is worthy of careful trial. Brighton is a very fine red sort, but must have good cross pollination to set well. Woodruff, Lindley and Wyoming Red are red grapes grown to some extent. Salem and Wilder are of value for home use and market. There is a splendid opportunity for amateurs to raise some of the finer sorts which require more care than the average commercial grower can give to them. For this purpose some of the vinifera hybrids may be used and even some of the pure vinifera varieties, such as are grown in California, will succeed if vines are carefully sprayed and the canes are laid down and buried with earth for winter protection. The vinifera types should be grafted on phylloxera resistant roots. Stock of many of these varieties are difficult to secure as they are not generally propagated by nurserymen. The following sorts are suggested as being worthy of a place in the amateur's collection. Barry, Black Eagle, Iona, Downing, Dutchess, Jefferson, Mills, Rochester, Triumph, Secretary and Armalaga. Vinifera sorts which may be tried are Flame Tokay and Mission.

GRAPE DISEASES AND INSECTS.

Black Rot.—This is a fungous disease spotting the leaves and rotting the fruit and doing immense damage in some seasons. It is most prevalent in moist warm climates.

Treatment.—After growth has started spray five or six times with Bordeaux mixture at intervals of two weeks. Use the 4-3-50 formula. If desired for the last spraying to prevent discoloring the fruit, neutral copper acetate, one pound to 50 gallons of water, may be used. Bagging bunches with four-pound manilla paper bags just after blossoming is almost a complete protection from black rot on the fruit. This is also a protection from birds and bees.

Downy Mildew.—This disease appears as downy white spots on the leaves, also attacks the fruit. Some varieties are more susceptible to the mildew than others, but on varieties subject to it, it is very destructive. Niagara seems to be more injured than other commercial varieties grown in this State.

Treatment.—The treatment recommended for the black rot will answer for this also.

Leaf Hoppers.—This insect causes considerable damage to the foliage, lessening the vigor of the plant and preventing the proper development of fruit.

Treatment.—As the mature insect winters over in fence rows or where leaves or other material are allowed to collect, the burning of such rubbish in the fall is a good preventive measure. Most of the damage is done by the young nymphs and spraying with "Black Leaf 40," one part to 1,600 parts of water or bordeaux, should be done during the latter part of May.

Flea Beetle.—There has been much complaint the last year or two of injury from this insect, which feeds on the flower clusters, often ruining the entire crop. This is a small, steel blue insect, which hops away when approached.

Treatment.—Upon the appearance of the pest spray with a solution consisting of 4 pounds arsenate of lead, 1 gallon glucose or molasses and 50 gallons of water.

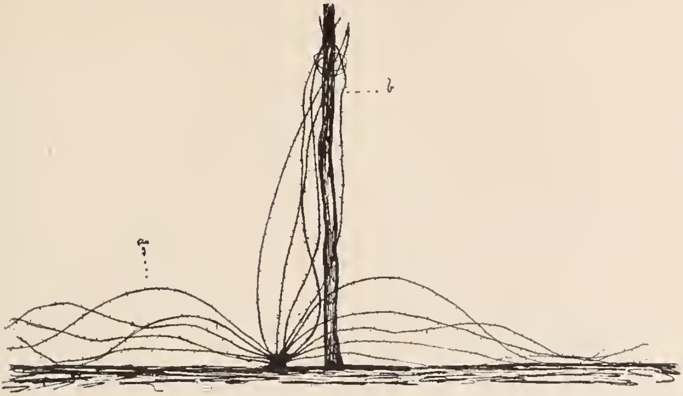


Fig. 1.—Staking Dewberries, (a), new growth allowed to sprawl on ground, (b) new growth pruned and tied up in spring.

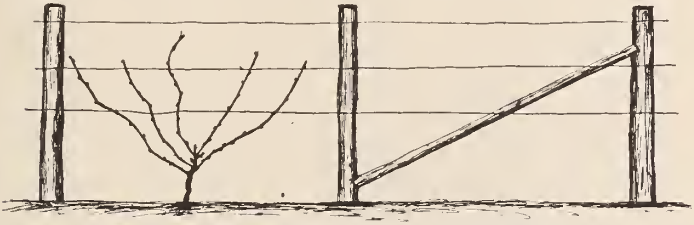


Fig. 2.—Brace for Trellis and Fan System.

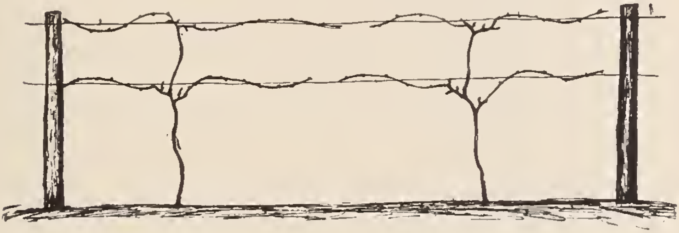


Fig. 3.—Two-wire Kniffin System.

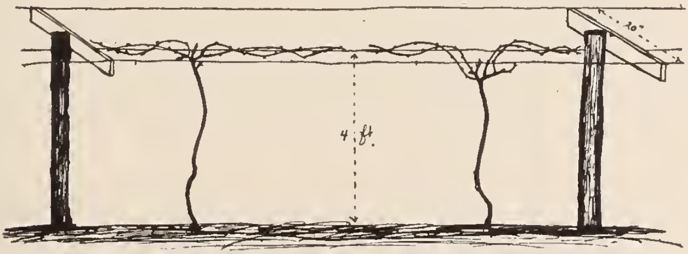


Fig. 4.—Munson Canopy Trellis.

THE MARYLAND AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 183 MAY, 1914.

BIOCHEMICAL AND PHYSIOLOGICAL STUDY OF THE REST PERIOD IN THE TUBERS OF SOLANUM TUBEROSUM.

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Introduction.

The cause and control of the rest period in plants have long been a subject of study, not only on account of their scientific interest, but also on account of the practical values which would accrue in many cases if the rest period were subject to control. Although many seeds have a rest period, this paper is concerned mainly with the rest periods in stems.

In spite of the immense amount of work that has been done on this problem, there still exists today two schools of thought, which stand directly opposed to each other on the first and most fundamental question involved; one school claims that the rest period is a direct response to changing external conditions, while the other considers it the result of fixed, hereditary, internal causes. A middle ground is taken by others who attribute the rest period to a "co-operation of an hereditary tendency to rythm with the after affect of periodic repetition of reactions induced by external conditions." This diversity of opinion may be attributed largely to the variety of material used for the study of the problem and to the lack of exact and reliable experimental data.

Historical.

As examples of the extreme views in the older literature, we may mention those of Grisebach and Askenasy[2]. The former considered the yearly periodicity of plants of the temperate regions entirely an hereditary property, induced probably by physiological selection due to alternating external conditions through a long series of years; whereas the latter claimed that it is due directly to external conditions. Sachs believed that the rest period is caused by a deficiency of soluble food and the cessation of the rest is due to a gradual production of enzymes. He does not state whether internal or external causes are responsible for the deficiency of food, nor does he suggest the nature of the process which increases the enzymes. Fisher[14] studied the carbohydrate transformation in woody stems during the rest period and concluded that periodicity of growth is conditioned by a periodicity of the processes of food changes, which in turn rest upon an hereditary periodicity of certain properties of the protoplasm.

Coming now to the more modern literature, the long studies of Müller-Thurgau and O. Schneider-Orelli[37] are of great importance in the solution of this problem. Müller-Thurgau's[35] original conception was very similar to that of Sach's. Their more recent combined studies, however, have led them thus far only to the most general conclusions. They think the winter rest of plants is not conditioned by low temperature only, but the cessation of growth rests also upon the internal properties of the protoplasm of the meristem. These internal properties are inherited effects of winter cold on the growth process which after a long time become fixed in the protoplasm.

Howard[18] experimented with a large number of trees and shrubs, all deciduous species native to the temperate zone. He first tested their ability to grow in winter under favorable greenhouse conditions and then subjected to artificial treatments those which failed. Discussing the results of the above experiments, the author states: "This shows conclusively, that the majority of species, indigenous to the temperate climates, do not have firmly fixed winter rest periods from which they can not be awakened." Although his observations were made on plants in winter rest, he includes also summer rest periods in his general conclusions. He thinks both forms of rest are caused by unfavorable external conditions. If these conditions, such as cold or drought occur at regular intervals, a plant readily adapts itself to the new demands and the rest becomes a habit, which may continue to be repeated automatically for a longer or shorter period of time. The habit of rest thus induced is often very strongly fixed and is apparently transmissible.

Euler[13] attributes the rest period to internal self-regulatory processes and theorized in the following ingenious manner regarding the nature of these processes: The growth of a young cell shows two phases which follow each other by self regulation. The first or stretching phase shows an increase of soluble osmotically active cell constituents; the second is characterized by the building up of the soluble materials into insoluble or colloidal molecules. Hydrolysis and synthesis, however, proceed simultaneously and the two phases are characterized by an excess of the one process over the other. The synthesis of the second phase fixes the stretching of the first phase. What applies to the single cell applies also to the development of the entire organ and organism. In a number of cases, new cycles of stretching and condensation follow one another with unbroken regularity. In many other cases a new cycle does not immediately follow upon the ending of a previous one. The stretching phase is prevented on account of an inability to dissolve the highly complex reserve materials. A short or long rest period must first take place. Finally a point is reached—and this point determines the length of the rest period—when the synthetic processes no longer hold the simultaneously occurring hydrolytic processes in equilibrium, and as a result internal osmotic pressures are increased. The resting organ is now physiologically ripe and begins to germinate, external conditions being favorable. As long as condensation processes predominate in the resting organ, germination is impossible. Therefore, according to Euler, after-ripening would simply consist in certain changes during the rest period, which weaken the synthetic processes. This theory does not, however, explain the origin and character of these changes.

The important observations of Schimper[44] gave us the first real knowledge of the peculiar behavior of tropical vegetation in respect to growth and rest periods. In places of favorable moisture and temperature conditions the entire year, many plants show a rhythmic alteration of periods of rest and activity of the growth processes. Schimper states: "Internal causes are mainly or solely responsible for the alternation of rest and activity in a nearly uniform climate. Such a rhythmic change is, however, never abandoned, for it arises from the nature of the living organism and not from external conditions; its connection with external conditions is a secondary feature —an adaption."

From the time of Schimper's observations, tropical vegetation has been favorite material for study in determining the relation of external conditions to rest periods. Klebs[30] has made observations on the tropical vegetation of Java where climatic conditions show little variation. Exact measurements of twigs were made to determine the amount of growth over a series of months. He also cultivated a number of European and Japanese plants in Java. Native plants of Java were likewise transplanted to Heidelberg and grown in a greenhouse under constant temperature and moisture conditions. These studies which constitute his most recent research on this problem, led him to firmly deny a periodicity of growth, which is independent of external factors and to formulate the following hypothesis to account for this rest period in tropical trees: When the growth ability is weakened by a deficiency of one or more of the essential external growth factors, carbon assimilation proceeds at first at the normal rate, resulting in a storage of organic materials. These in turn render certain enzymes inactive and thus cause a rest period. All means available for shortening the rest period simply activate these enzymes. Great stress is laid upon salts as the causal agent in the rest periods of tropical plants, since the other three factors are constantly favorable for growth in Java.

Volkins [49,50] made more extended observations on the tropical vegetation in its natural habitat. Trees were marked and observed for an entire year. Many new and interesting facts were added to our stock of knowledge regarding rest and activity in tropical plants. Although his observations were made in the same place as those of Kelbs and often on the same object, he arrives at quite a different conclusion. He is unable to see any relation between the rest periods in tropical plants and external conditions; they must be due to internal causes. He does not intimate, however, the nature of these causes.

It is true Volkens does not include the factor of salts among the external conditions that may effect the growth processes; and besides he and Klebs do not seem to have quite the same conception of internal causes so their views may not be as antagonistic as first seems. According to Volkens, everything is conditioned by internal causes, which can not be brought into evident connection with external factors. The important thing to Klebs is whether the rest is caused by the outer world or is an expression of an internal fixed "specific structure." Volkens does not discriminate between specific structure and internal conditions. It is conceivable that a slight external change may set into motion a chain of effects which would ultimately so change the internal conditions of the growing cell or its immediate environment that growth would be arrested and seem to be due to internal specific structure.

Attempts to shorten the rest period of buds and bulbs by artificial means are numerous and some have been successful. Müller-Thurgau[36] claims to have shortened the rest period of potato tubers by one month's storage at O°C. The use of ether and chloroform dates from the important work of Johannsen, [24] who succeeded by their means in forcing buds to open from three to six weeks earlier than normally. He found, however, that these agents are effective only at the beginning and near the end of the rest periods. The warm bath has been used successfully in shortening the rest period. Molisch[33] caused an earlier opening of buds by immersing the shoots in water at 35°C. Müller-Thorgau and O. Schneider-Orelli[38] hastened the growth of lily of the valley bulbs and potato tubers by warming them at a temperature of 38°C. and maintaining a germination temperature of 26°C. Warm air was equally as effective as warm water. In an endeavor to test Kleb's conception regarding the importance of salts in bud growth, Lakon[32] stood cut twigs of trees and shrubs in Knop's solution and found that of a large number only one failed to show an earlier unfolding of the buds than normally. This does not prove, however, that the buds failed to germinate on account of the lack of salts any more than the lack of ether prevented germination in Johannsen's experiments. Jesenko[21] found that hydrochloric, sulphuric and tartaric acids as well as alcohol and water saturated with carbon dioxide hastened the germination of buds of a number of woody plants. He concluded that the applied solutions acted not only as a stimulus in the strict sense of the word, but also set going certain chemical processes in the buds which produced favorable conditions for growth. Jost[22] observed that wounded potatoes, especially if they were cut into many pieces, showed an earlier germination of the buds than the unwounded ones.

Wismewski[54] experimented with the winter buds of certain aquatic plants. The rest period of the buds of Hydrocharis Morsus ranae could be shortened by wounding and lengthened by darkness. Turionen formed buds the entire winter when kept in darkness and immersed in rain water or a nutritive solution. He concludes that neither the origin nor germination of these buds is conditioned by an inner rhythm of the plants. He also states that low temperature is not a necessary condition for the origin of buds.

Although the rest period may be shortened by artificial treatments, none have thus far been capable of entirely eliminating the rest period where it is well fixed.

A great deal of work has been done on forcing resting stem structures into growth by artificial means, but comparatively little has been done to determine the character of the physiological and chemical changes effected by such treatments.

Müller-Thurgau and Schneider-Orelli[37,38] found increased respiration in potato tubers and lily of the valley bulbs after the warm bath treatment and also after etherizing.

Iraklionow[47] also found a rise in respiration of potato tubers after treatment with warm water. At the end of a few days, however, it fell back to the normal rate and did not rise again until the beginning of germination. He assumes, in agreement with Molisch, that the breaking of the rest period by means of the warm bath is a simultaneous action of the high temperature and the water, and that the warm bath influences the enzymes, chiefly the oxidases.

Butkewitsch[7] showed that the stored starch in the cortex and wood can be dissolved by the action of toluol and chloroform and also by high temperature. He thinks the action is similar to cold and consists in a weakening of the plastids.

Grüss[16] investigated the chemical changes set up in the cells around the wound in potatoes and found an increase in the oxidizing enzymes and in diastase activity. There was some sugar accumulation in the subphellegon. Müller-Thurgau was probably the first to observe the accumulation of sugar in potatoes stored at low temperatures. The writer[3] in a previous paper showed that both reducing sugars and sucrose accumulate during storage at 0°C. The increase in sucrose was more rapid at first than the increase in reducing sugars, but by the end of six weeks of storage the percentage of reducing sugars was twice that of sucrose. The juice from the cold storage potatoes showed a slightly greater diastase activity during the first four weeks of storage. Catalase suffered a gradual reduction during storage a 0°C.

Even less is known about the chemical changes during the natural rest period. Fisher[14] studied the changes in the starch content of trees during the rest period. He found the maximum of starch from leaf fall to the beginning of November. Starch solution began in November and reduced the starch content to the minimum in the winter. Starch synthesis began in March and reached the maximum again in April, after which hydrolysis began and brought the starch content to the minimum during the latter part of May or the time of the beginning of vegetative activity. Storage of starch occurred of course during the summer.

BIOCHEMICAL.

It is obvious from the above survey of the literature that there is little exact experimental data on the chemical and physical situation in stems which forces the growing cells into a period of rest. The same is true of the changes in the resting tissue or its immediate environment, which are essential to the release of the growth processes at the end of the rest period. These latter changes will be spoken of as after-ripening, using the term in its broadest sense.

It is a well known fact that under normal conditions potato tubers will not sprout for several weeks after harvest. Rehobeth potatoes harvested July 17th and planted immediately in the same field did not sprout until October, although good growing conditions prevailed during the entire period. McCormick potatoes harvested November 11th, and kept constantly under favorable growing conditions in the greenhouse did not sprout until January 24th; general sprouting did not occur until February. It has been generally conjectured that the after-ripening processes in tubers are metabolic in character; in other words, it has been supposed that chemical changes occur in the tubers during the rest period, which render certain essential foods or other materials available for the growing bud. The first problem in the following study was to ascertain if there are metabolic processes occurring in the potato tuber during the rest period, which are characteristic of after-ripening and to determine their character as far as possible.

The tubers used in this investigation produce sprouts much earlier from the buds on the seed or terminal end when the tubers are left whole. In the majority of cases, the buds on the stem or basal end do not germinate at all unless those on the seed end are injured. Therefore, tubers were cut in half at regular intervals during the rest period and the following analyses made separately on the seed and stem halves with the view to better detect the chemical changes characteristic of after-ripening. We are not justified in assuming that all chemical changes occurring in the whole tuber during the rest period must be peculiar to after-ripening.

Carbohydrates.—In a previous chapter it was stated that storage at low temperature has been claimed to be capable of shortening the rest period of potato tubers. It has been proven that during such storage sugar accumulates in the tubers. These facts have led to the supposition that the rest period is caused by a deficiency of soluble carbohydrates and that the cessation of the rest is due to a gradual production of diastase. In order to determine if carbohydrate transformations are essential after-ripening process or simply due to changing temperature, analyses were made during after-ripening of tubers at a fairly constant and favorable growing temperature. At the same time analyses were made on tubers stored under variable lcw temperature in a potato vault. Samples of eight tubers each with a total weight of about one kilogram were selected from both lots at intervals of two and four weeks. Each tuber was cut into two equal parts; the one half representing the terminal or seed end, the other, the basal or stem end. The seed ends of each sample were all grated together, likewise the stems ends. After thoroughly mixed in a mortar, both lots of pulp were sampled for determinations of moisture, starch, total sugar, reducing sugar and diastase.

METHODS.

Moisture.—Approximately five grams of pulp were placed between ground watch glasses and accurately weighed, after which the pulp was covered with absolute alcohol and dried in a Soxhlet oven at 100°C. until most of the moisture was driven off. It was then dried to constant weight at 100°C. under reduced pressure in a vacuum oven. The alcohol prevents the rapid oxidation at the beginning of the drying and also prevents the starch from becoming a paste difficult to dry, and forming a horny mass after drying, which is very hard to remove from the watch glasses.

Total and Reducing Sugars.—50 grams of pulp were extracted with 50 per cent alcohol one hour on the water bath and the sugar determined according to the method of Munson and Walker (48). Sufficient calcium carbonate to neutralize the acidity was added before extraction.

Starch.—The starch determination was made according to the method of the Official Agricultural Chemists (48).

The final carbohydrate results are calculated to original moisture basis. It is thus possible to record results in percent of wet weight, as the possibility of apparent changes due to loss of water by evaporation is excluded. Apparent changes due to this water loss would also be excluded by calculating results to dry basis at time of analysis, but these results might still show changes due to water taken up by hydrolysis or to the accumulation of respiratory water, especially where evaporation is prevented. This method does not, however, take into account loss in dry matter through respiration. In the case of the vault stored potatoes this would be negligible since respiration is very low at the vault temperature.

TABLE 1.

MOISTURE; McCORMICK POTATOES PLANTED IN WET SAWDUST IN GREENHOUSE; TUBERS SPROUTING ON MARCH 26th.

DATE OF ANALYSIS	MOISTURE		
	Seed End Per Cent.	Stem End Per Cent.	Whole Tuber Per Cent.
November 14..........	79.68	79.38	79.53
December 14..........	80.71	80.75	80.75
January 20............	81.57	81.07	81.32
February 3............	80.43	80.51	80.47
March 26..............	81.64	82.27	82.00

TABLE 2.

MOISTURE; GREEN MOUNTAIN POTATOES STORED IN VAULT.

DATE OF ANALYSIS	MOISTURE		
	Seed End Per cent	Stem End Per cent	Whole Tuber Per cent
November 28..........	81.17	80.71	80.94
December 20..........	80.16	80.01	80.08
January 13............	80.11	78.78	79.45
February 13	81.30	79.83	80.06

TABLE 3.

REDUCING SUGAR; McCORMICK POTATOES PLANTED IN WET SAWDUST IN GREENHOUSE; TUBERS SPROUTING ON MARCH 26th.

DATE OF ANALYSIS	RANGE OF TEMPERATURE BETWEEN ANALYSES	REDUCING SUGAR Calculated on basis of original moisture		
		Seed End Per Cent	Stem End Per Cent	Whole Tuber Per Cent
November 14..	———	.287	.320	.304
December 14..	20 C to 22 C	.372	.342	.357
January 20....	22 C to 17 C	.478	.481	.479
February 3....	20 C to 22 C	.274	.311	.293
March 26......	21 C to 23 C	.385	.401	.393

TABLE 4.

REDUCING SUGAR; GREEN MOUNTAIN POTATOES STORED IN VAULT.

DATE OF ANALYSIS	RANGE OF TEMPERATURE BETWEEN ANALYSES	REDUCING SUGAR Calculated on basis of original moisture		
		Seed End Per Cent	Stem End Per Cent	Whole Tuber Per Cent
November 28..	—— to 5°C	.655	.745	.70
December 20..	5°C to 2°C	.972	1.40	1.19
January 13....	2°C to —1.5°C	1.35	1.85	1.60
February 13...	—1.5°C to —1°C	2.20	2.62	2.40

TABLE 5.

TOTAL SUGAR; McCORMICK POTATOES PLANTED IN WET SAWDUST IN GREENHOUSE; TUBERS SPROUTING ON MARCH 26th.

DATE OF ANALYSIS	RANGE OF TEMPERATURE BETWEEN ANALYSES	TOTAL SUGAR Calculated on basis of original moisture		
		Seed End Per Cent	Stem End Per Cent	Whole Tuber Per Cent
November 14..	————	.663	.667	.665
December 14..	20°C to 22°C	.572	.503	.538
January 20....	22°C to 17°C	.663	.626	.645
February 3....	20°C to 23°C	.430	.413	.408
March 26......	21°C to 23°C	.537	.553	.545

TABLE 6.

TOTAL SUGAR; GREEN MOUNTAIN POTATOES STORED IN VAULT.

DATE OF ANALYSIS	RANGE OF TEMPERATURE BETWEEN ANALYSES	TOTAL SUGAR Calculated on basis of original moisture		
		Seed End Per Cent	Stem End Per Cent	Whole Tuber Per Cent
November 28..	—— to 5°C	1.02	1.19	1.10
December 20..	5°C to 2°C	1.48	1.76	1.62
January 13....	2°C to —1.5°C	1.94	2.26	2.10
February 13...	—1.5°C to —1°C	3.84	4.04	3.94

TABLE 7.

STARCH; McCORMICK POTATOES PLANTED IN WET SAWDUST IN GREENHOUSE; TUBERS SPROUTING MARCH 26th.

DATE OF ANALYSIS	RANGE OF TEMPERATURE BETWEEN ANALYSES	STARCH Calculated on basis of original moisture		
		Seed End Per Cent	Stem End Per Cent	Whole Tuber Per Cent
December 14..	20° C to 22 C	15.56	15.94	15.75
January 20....	20° C to 17° C	14.94	15.33	15.14
February 3....	20° C to 23° C	16.00	16.23	16.12
March 26......	20° C to 23 C	14.34	13.91	14.13

TABLE 8.

STARCH; GREEN MOUNTAIN POTATOES STORED IN VAULT.

DATE OF ANALYSIS	RANGE OF TEMPERATURE BETWEEN ANALYSES	STARCH Calculated to original moisture basis		
		Seed End Per Cent	Stem End Per Cent	Whole Tuber Per Cent
November 23..	— to 5° C	14.35	13.84	14.10
February 13...	5° to —1° C	12.29	12.96	12.62

The smaller percent of water in the stem end of the vault stored tubers indicates a greater water holding power of the seed end, since the difference becomes greater with storage. The apparent increase in moisture in the last sample is due to the fact that the tubers were near the damp wall and down deep in the pile where evaporation would be slight. The tubers in the wet sawdust where evaporation was prevented showed no difference in the moisture content of the two ends. The percentage of water in the tuber as a whole increased under these conditions; no doubt due to the accumulation of respiratory water.

Failure of growth in the buds during the rest period is not due to a lack of available sugar, since the percentage of both reducing and total sugars in the greenhouse stored tubers was no greater when sprouting began than at the beginning of the rest period; besides the seed end at the time of sprouting did not contain a greater percentage of sugar than the stem end. *The carbohydrate transformations during the rest period are entirely dependent upon changing temperature and must therefore, not be considered after-ripening* *processes.* Temperatures around 0°C are necessary for any considerable amount of sugar accumulation, but a few degrees change at much higher temperatures will cause a change in the sugar content, as shown in table 5. The stem end accumulated both reducing and total sugars more rapidly than the seed end. It also seems to possess less ability to synthesize starch at low temperatures.

Diastase.—Since the supply of soluble carbohydrates for the growing buds is dependent upon the important enzyme diastase, a gravimetric method was employed to determine the diastatic power of the juice from the two ends at intervals during after-ripening under greenhouse and vault conditions. The determinations were made on the same samples used for the carbohydrate analyses.

METHOD.

100 grams of pulp were weighed into a wide mouth 200 c. c. flask and extracted with 75 c. c. of glycerine for 24 hours at 10°C.—12°C. 1 c. c. toluol was added as a further insurance against bacterial activity. After the extraction, the flask was made up to the mark with water and the contents strained through absorbent cotton, which was finally folded over the pulp and pressed in a tincture press. The extract stood in a tall mixing cylinder for one hour to allow the starch to settle out; 50 c. c. was then drawn off and placed into a 200 c. c. flask to which was added 25 c. c. soluble starch solution and 3 c. c. toluol. The extract was allowed to act upon the soluble starch solution for 48 hours at a constant temperature of 40°C. Another 50 c. c. were drawn off and placed into a 200 c. c. flask and cleared by making up to the mark with a saturated solution of lead acetate and filtering. The lead acetate was removed from the solution by adding anhydrous sodium carbonate to slight alkalinity and filtering. The reducing sugar was at once determined in 50 c. c. of the filtrate by the method of Munson and Walker. Another 50 c. c. was placed in a 100 c. c. flask and the sucrose inverted by adding 5 c. c. hydrochloric acid, which was allowed to act 24 hours at a room temperature. The flask was made up to the mark with water and poured into a tall beaker. The acid was just neutralized with anhydrous sodium carbonate and the total sugar determined in 50 c. c. of the solution. The final results represent the amount of reducing sugar in 6.25 grams and of total sugar in 3.125 grams of the original sample.

The slight error introduced by the space occupied by the weight of dry pulp, when the extraction flask was made up to the mark, make the final results a little higher than the actual amounts of sugar present. This error, however, does not effect the object of these determinations. By starting with a 100 c. c. sample the error of sampling the wet pulp is minimized and a more active extract is obtained. Exactly the same procedure as the above was followed to determine the reducing and total sugars in the 50 c. c. of extract after incubation. The enzyme action was stopped by making the flasks up to the mark with the saturated solution of lead acetate immediately after incubation.

TABLE 9.

ACTION OF GLYCERINE EXTRACT OF POTATO PULP ON SOLUBLE STARCH SOLUTION; McCORMICK POTATOES STORED IN WET SAWDUST IN THE GREENHOUSE; TUBERS SPROUTING MARCH 26th.

Date of Analysis	Range of Temperature Between Analyses	Increase in Milligrams of Sugar in 24 Hours at 40° Per 100 Grams of Potato Pulp					
		Reducing Sugars			Total Sugar		
		Seed End	Stem End	Whole Tuber	Seed End	Stem End	Whole Tuber
November 14..	———	65.	58.	61.5	65.6	60.	62.8
December 14..	20°C to 22°C	63.2	56.	59.5	86.3	72.	79.0
January 20....	22°C to 17°C	91.0	67.2	79.1	72.1	60.5	66.3
February 3....	20°C to 22°C	84.0	66.4	76.8	78.4	63.9	71.1
March 26......	21°C to 23°C	133.0	188.2	158.0	115.2	150.4	132.81

TABLE 10.

ACTION OF GLYCERINE EXTRACT OF POTATO PULP ON SOLUBLE STARCH SOLUTION; GREEN MOUNTAIN POTATOES STORED IN VAULT.

DATE OF ANALYSIS	RANGE OF STORAGE TEMP. BETWEEN ANALYSES	INCREASE IN MILLIGRAMS OF SUGAR IN 24 HRS. AT 40° C PER 100 GRAMS OF POTATO PULP					
		REDUCING SUGAR			TOTAL SUGAR		
		Seed End	Stem End	Whole Tuber	Seed End	Stem End	Whole Tuber
November 28..	—— to 5° C	50.5	112.0	61.3	51.2	43.2	47.2
December 20..	5° C to 2° C	113.5	211.0	162.3	51.3	45.0	48.1
January 13 ..	2 C to —1 C	170.5	271.5	171.0		44.5	
February 13...	—1.5° C to —1° C	225.5	488.5	352.0		48.0	

The increase in the total sugar after incubation may be considered an index of the diastatic activity of the potato extract at the time of analysis, or it may simply indicate the excess of the hydrolytic process over a simultaneously occurring synthetic process. On this basis both the greenhouse and vault stored potatoes contained an active diastase at all times during the rest period. It was uniformly greater in the seed end, but there was no appreciable increase in either end during the rest period. It may be concluded, therefore, that the *cessation of the rest period is not due to a gradual production of active diastase.*

The fact that the reducing sugar shows a greater increase after incubation than the total sugar (table 10) indicates the presence of an active invertase in the tuber at all times during the rest period. The gradual increase of reducing sugar in the juice of the cold storage tubers after incubation is not to be considered due to an increase of invertase during cold storage. It seems to be due rather to the inversion at the incubation temperature of the sucrose which accumulates with cold storage; low temperature retards the action of invertase more than the process producing sucrose. At temperatures from 20° C. 40° C. the equilibrium point between the invert sugar and sucrose is nearly constant regardless of the amount of total sugar present.

Oxidase.—The juice from new potatoes shows less ability to accelerate the oxidation of pyrogallol than the juice from tubers at the end of the rest period. The juice from the seed half causes no greater acceleration of this oxidation than that from the stem half, even after sprouting.

METHODS.

The rate of oxidation of pyrogallol was determined in Bunzel's (5) apparatus. Two c. c. of freshly prepared juice was allowed to act upon 8 c. c. of a 5 percent solution of pyrogallol. The apparatus was placed in a constant temperature incubator and shaken twenty-five times every hour the first day and every two hours the second day. It was found that by this amount of shaking results could be obtained which were fairly proportional to the amount of juice used. The two samples of juice to be compared were tested at the same time and under exactly the same conditions.

TABLE 11.

OXIDATION OF PYROGALLOL BY JUICE FROM IMMATURE TUBERS JUST HARVESTED AND BY JUICE FROM TUBERS OF THE SAME VARIETY AT THE END OF THE REST PERIOD, BUT NOT SPROUTING.

Elapsed Time	Temperature at the Time of Reading	Manometer Reading Expressed in Centimeters of Mercury	
		New Tuber	Old Tuber
Hours	°C		
3	33.8	—.65	—.7
22	33.8	–1.55	–1.9
25	34.0	–1.70	–2.2

TABLE 12.

OXIDATION OF PYROGALLOL BY JUICE FROM NEW TUBERS AND FROM TUBERS OF THE SAME VARIETY AT THE END OF THE REST PERIOD, BUT NOT SPROUTING.

Elapsed Time	Temperature at the Time of Reading	Manometer Readings Expressed in Centimeters of mercury		
		New Tuber	Old Tuber	Old Tuber Calculated to moisture of New Tuber
Hours	°C			
5	34.6	—.4	— .6	— .55
26	34.6	.8	–1.15	–1.05
46	34.6	—.85	–1.35	–1.24
71	34.6	–1.50	–2.00	–1.83
125	34.6	–3.05	–3.4	–3.02

TABLE 13.

OXIDATION OF PYROGALLOL BY THE JUICE FROM THE SEED AND STEM HALVES, NOVEMBER 17th.

Elapsed Time	Temperature at the Time of Reading	Manometer Readings Expressed in Centimeters of Mercury	
		Seed Half	Stem Half
Hours	C		
24	36.6	—1.2	—1.10
43	37.0	—2.15	—1.85

TABLE 14.

OXIDATION OF PYROGALLOL BY JUICE FROM THE SEED AND STEM HALVES, JANUARY 10th.

Elapsed Time	Temperature at the Time of Reading	Manometer Readings Expressed in Centimeters of Mercury	
		Seed Half	Stem Half
Hours	C		
4	34.6	—.75	—.75
6	34.7	—1.45	—1.45
48	34.5	—2.85	—2.90

TABLE 15.

OXIDATION OF PYROGALLOL BY THE JUICE FROM SEED AND STEM HALVES, MARCH 10th; TUBERS SPROUTING FROM SEED END.

Elapsed Time	Temperature at the Time of Reading	Manometer Reading Expressed in Centimeters of Mercury	
		Seed End	Stem End
Hours	°C		
2	34.8	— .3	— .35
7	34.4	— .75	— .80
27	34.7	—1.20	—1.20
53	34.4	—1.80	—1.80
77	34.4	—2.10	—2.10

Nitrogen.—A general survey of the different combinations of nitrogen in the tuber was made at intervals during the rest period in order to determine if protein hydrolysis or other transformations of the nitrogen containing substances occur during the rest period as necessary antecedents to sprouting. The following determinations were made: Total nitrogen, water soluble nitrogen, nitrogen coagulated by heat, nitrogen precipitated by tannic and by phosphotungstic acids. It was assumed that the nitrogen coagulated by heat represented the protein nitrogen and the difference between this and the nitrogen precipitated by tannic acid the proteose and the peptone nitrogen. The nitrogen not precipitated by phosphotungstic acid was considered the nitrogen of monoamino acids and their amide derivatives, while the difference between this and the nitrogen not precipitated by the tannic acid was considered the nitrogen of diamino acids and other bases. It is not claimed that the above precipitation method gives absolutely the true proportion of nitrogen in the various forms of binding but it yielded valuable comparative results under the conditions employed in the determinations.

METHODS.

100 gram samples of the pulp were weighed into 400 c. c. beakers and extracted with 200 c. c. of water for two hours. The pulp was stirred every five minutes. The contents of the beakers were then strained through four thicknesses of cheese cloth and pressed in a tincture press, after which the dry pulp cake was transferred to the beaker again. The press was washed with 100 c. c. of water, which was caught in the beaker containing the pulp; 10 drops of chloroform were then added and the beakers allowed to stand in a cool place over night. In the morning, the contents of the beakers were again poured on to the same cheese cloth and pressed; then the pulp and press were washed with water until the total volume of the extracts and wash water was brought up to 500 c. c. The flasks were shaken and poured into 500 c. c. graduates and allowed to stand one hour for the starch to settle out; 100 c. c. of the extract were then placed into each of three 250 c. c. flasks. To one was added three drops of acetic acid and the mixture heated on the water bath until the liquid was perfectly clear. One gram of NaCl and 1 c. c. of a 12 percent solution of tannic acid were added to the second flask. To the third flask were added 5 c. c. of concentrated sulphuric acid and 5 c. c. of a 30 percent solution of phosphotungstic acid. The above amounts were found sufficient for complete precipitation. After standing a little time, all the flasks were made up to the mark with water and the contents filtered. 100 c. c. of each of the clear filtrates were transferred to kjeldahl flasks, 20 c. c. of sulphuric acid added and the extracts evaporated down and digested for a nitrogen determination. The results represent the amounts of nitrogen in 8.33 grams of the pulp not coagulable by heat, and the amounts in 8.33 grams not precipitated by tannic and phosphotungstic acids.

The extract remaining in the graduate was filtered and 50 c. c. of the filtrate used for a determination of the water soluble nitrogen. Seven to eight gram samples of the fresh pulp were weighed from weighing bottles for the total nitrogen determinations. All sampling was done in duplicate and the final results represent the average of two determinations.

The nitrogen determinations were made on Green Mountain potatoes harvested November 4th and planted at once in wet sawdust on the floor of the greenhouse. The temperature variation in the sawdust was slight and the tubers were constantly under favorable growing conditions. Sprouts began to appear on this lot of potatoes on January 19th. The set of analyses made on January 18th, therefore, shows the nitrogen situation just at the end of the rest period. The tubers used for the last set of analyses bore sprouts from one-eighth to one inch in length. As soon as sprouting began, the tubers were placed in a moist chamber, which was buried in the sawdust, therefore, nothing was absorbed by the roots except possibly a little water. Each sample contained six tubers with a total weight of about 800 grams. The variation in total weights was not more than 5 grams. The samples were all weighed the day after the potatoes were harvested and kept separate during the storage in the wet sawdust This makes possible the calculation of results to percent of original weight and thus apparent changes due to loss in dry substance through respiration and also through changes in water content are avoided.

On the above basis of calculation, the different forms of nitrogen in the whole tuber showed no general change until the tubers began to sprout. During the rest period the stem half always showed a higher percent of nitrogen, calculated to percent of total nitrogen, in the following forms: monoamino acids and amides, diamino acids and other bases, proteoses and peptone. The seed half contained a slightly higher percent of both water soluble, and water insoluble protein nitrogen. *The slight variation in the relative magnitudes of the above forms of nitrogen during the rest period was no greater than would be expected in different biological samples; in most cases it was well within the experimental error.*

TABLE 16.

NITROGEN OF THE WHOLE TUBER CALCULATED TO PERCENT OF TOTAL WEIGHT OF EACH SAMPLE ON NOVEMBER 8th; TUBERS SPROUTING ON FEBRUARY 12th.

DATE OF SAMPLING	TOTAL NITROGEN	WATER SOLUBLE NITROGEN	NITROGEN NOT COAGULATED BY HEAT	NITROGEN NOT PRECIPITATED BY TANNIC ACID	NITROGEN NOT PRECIPITATED BY PHOSPHOTUNGSTIC ACID
November 10..	.430	.365	.232	.217	.205
November 29..	.432	.371	.234	.222	.210
December 13..	.429	.369	.225	.211	.198
December 27..	.428	.367	.234	.222	.213
January 18 ...	.424	.345	.229	.217	.205
February 12...	.428	.381	.239	.228	.223

TABLE 17.

DISTRIBUTION OF NITROGEN IN PERCENT OF TOTAL NITROGEN; TUBERS SPROUTING ON FEBRUARY 12th.

Date of Analysis	Water Soluble Protein Nitrogen			Water Insoluble Protein Nitrogen			Non-Protein Nitrogen		
	Seed End	Stem End	Whole Tuber	Seed End	Stem End	Whole Tuber	Seed End	Stem End	Whole Tuber
November 10....	31.95	29.98	30.96	15.04	14.98	15.01	53.01	55.04	54.02
November 29....	32.41	30.77	31.59	14.49	13.75	14.12	53.10	55.48	54.29
December 13....	32.78	31.68	32.23	15.01	13.71	14.36	50.12	54 61	52.36
December 29....	30.74	31.18	30.96	15.58	12.87	14.22	53.68	55.95	54.31
January 18......	32.83	28.40	30.61	14.02	13.82	13.92	53.15	57.78	55.46
February 12.....	32.82	30.62	32.81	11.96	10.68	11.30	55.24	58.70	56.97

TABLE 18.

DISTRIBUTION OF NITROGEN IN PERCENT OF TOTAL NITROGEN; TUBERS SPROUTING ON FEBRUARY 12th.

	Proteose and Peptone Nitrogen			Nitrogen of Diaminoacids and Other Bases			Nitrogen of Monoamino Acids and Amides		
	Seed End	Stem End	Whole Tuber	Seed End	Stem End	Whole Tuber	Seed End	Stem End	Whole Tuber
November 10..	2.54	3.51	3.02	2.33	3.28	2.80	48.14	48.25	48.19
November 29..	2.49	3.50	3.00	2.32	2.79	2.56	48.29	49.19	48.72
December 13..	2.99	3.31	3.15	2.11	3.40	2.75	47.11	47.90	47.51
December 29..	....	....	....	2.08	3.10	2.59	48.42	50.71	49.56
January 18....	2.10	3.46	2.78	2.04	3.95	2.99	49.01	50.37	49.69
February 12...	3.71	3.69	3.70	1.11	1.80	1.45	50.43	53.21	51.75

Phosphorus.—Phosphorus is an essential element of two of the most important constituents of the cell, the nucleoproteins and the lipoids. Protein, lipoid and extractive phosphorus were determined at intervals during the rest period with the view to ascertain if certain gradual transformations of the phosphorus combinations occur during the rest period in order to render phosphorus available in the proper form for the growing buds.

Calculated to percent of total phosphorus it was found that the percent of extractive phosphorus was consistently higher in the seed end than in the stem end; the percent of protein phosphorus on the other hand was always less in the seed end. *The percents of all the phosphorus combinations were practically constant throughout the rest period.*

METHOD.

The method employed for the determinations was a modification of Koch's (27.28) method for animal tissues: 50 gram samples of the pulp were weighed into Erlenmeyer flasks and covered with enough 95 per cent alcohol to bring the final percentage up to at least 80 per cent. The flasks were allowed to stand four months. In the meantime, they were heated twice on the water bath to insure complete coagulation of the proteins. The contents of the flasks were filtered by suction through a hard smooth filter in a Buchner funnel; the last trace of substance being removed from the flask with hot alcohol. The pulp was dried in the funnel at a temperature of 60°C. After drying sufficiently to grind well, it was ground to a powder in a coffee mill, transferred to alundum thimbles lined with a glass cylinder and extracted eight hours with 95 percent alcohol. This was followed by an eight-hour extraction with ether and a final sixteen-hour extraction with absolute alcohol. All the extracts were now combined and evaporated on the water bath until the alcohol was driven off (an arrangement was devised to reclaim the alcohol). The aqueous emulsion was transferred to a 250 c. c. mixing cylinder, made up to 240 c. c. with 5 percent HCl and thoroughly shaken; after which 10 c. c. of chloroform were added and the cylinder again thoroughly shaken. The chloroform was first used in small portions to remove the last traces of liquid from the glass evaporating dishes. The cylinders were allowed to stand in a cool place until the aqueous portion became clear; this was then drawn off by suction through a long tube of small bore into a filtering flask. By exercising great care, the aqueous solution can be almost completely separated from the choloroform fraction in this manner. To insure complete separation, however, the cylinder was again made up to 250 c. c. with acid water and the above procedure repeated. It was found unnecessary to further wash the chloroform fraction as there were unappreciable amounts of phosphorus in the second wash water. Enough alcohol was added to dissolve the choloroform fraction which was then transferred to a kjeldahl flask and evaporated gently on the water bath; the residue was then digested with an acid mixture according to Neuman and the phosphorus determined by the Neuman method. The result represented the amount of lipoid phosphorus in 50 grams of the fresh pulp.

The dry pulp remaining after the alcohol and ether extractions was extracted three hours with 300 c. c. of 2 percent HCl by shaking every five minutes in an Erylenmeyer flask. The liquid was decanted on to the same filter used for the first filtration and filtered with suction. This extraction was followed by three 24-hour extractions with 300 c. c. of water. Chloroform was added to insure against bacterial activity, and all extractions were made at room temperature. After the last extraction, the entire contents of the flask were transferred to the filter and the flask washed several times with alcohol in order to completely remove the substance from the extraction flask and also to remove most of the water from the substance which was again dried on the filter at 70°C. All the water extracts, including those removed from the chloroform in the mixing cylinders, were evaporated down to about 150 c. c. and filtered through the same filter used in the two previous filtrations. After washing the very small amount of precipitate several times with water, the filtrate was transferred to a 250 c. c. flask and made up to the mark with water. An aliquot of 100 c. c. was drawn off and evaporated in a kjeldahl flask for a phosphorus determination. The result was the amount of extractive phosphorus in 20 grams of pulp.

The phosphorus left in the pulp after all of the extractions plus the small amount of residue impossible to remove from the filter paper used in all the filtrations, represents the protein phosphorus. As it was impracticable to digest the entire residue, a 2.5 to 3 grams sample was accurately weighed out for the phosphorus determination. The amount in the original 50-gram sample was then calculated; to this was added the phosphorus in the slight residue on and in the filter paper. The final results are averages of two determinations, duplicated at the time of sampling. The number and length of the extractions necessary for complete extraction was determined by repeated trials. The inorganic phosphorus was determined according to the method described by Collison (10).

TABLE 19.

EXTRACTIVE, PROTEIN AND LIPOID PHOSPHORUS CALCULATED TO PERCENT OF TOTAL PHOSPHORUS; McCORMICK POTATOES PLANTED IN WET SAWDUST IN THE GREENHOUSE; TUBERS SPROUTING ON MARCH 26th.

DATE OF SAMPLING	EXTRACTIVE P.			PROTEIN P.			LIPOID P.		
	Seed End	Stem End	Whole Tuber	Seed End	Stem End	Whole Tuber	Seed End	Stem End	Whole Tuber
November 14....	49.1	47.57	48.33	44.34	45.90	45.12	6.65	6.54	6.58
December 14....	50.50	46.76	48.63	43.50	47.13	45.31	6.003	6.099	6.006
January 20......	50.20	44.90	47.55	42.88	48.36	45.62	6.915	6.763	6.840
February 3......	50.81	44.60	47.70	41.14	48.11	44.62	8.056	7.29	7.673
March 26........	52.83	50.08	51.45	37.99	41.99	39.99	9.198	7.93	8.514

TABLE 20.

INORGANIC PHOSPHORUS IN PERCENT OF TOTAL PHOSPHORUS; GREEN MOUNTAIN POTATOES STORED IN WET SAWDUST IN THE GREENHOUSE; TUBERS SPROUTING ON FEBRUARY 12th.

DATE OF ANALYSIS	INORGANIC PHOSPHORUS		
	Seed End	Stem End	Whole Tuber
November 29.........	34.23	33.90	34.06
December 13.........	35.75	34.59	35.17
December 27..........	33.22	33.08	33.15
January 18............	32.71	34.11	33.41
February 12	32.00	34.30	33.15

Physiological.

Immature potatoes have a thin, slightly suberized skin which is quite permeable to both water and gases. As the tubers mature the skin becomes more suberized and more adherent to the underlying tissue. The rapidity and degree of suberization, however, is greatly influenced by moisture; dry conditions favor the process while moisture retards it. As the skin becomes suberized its permeability to water and gases is greatly reduced. It occurred to the writer that the skin may become very soon a sufficient barrier between the internal and external tissues to check growth in the buds. This might be due to an external agent becoming a limiting factor in the completion of the growth mechanism in the new tuber or in growth itself. The following experiments were planned to test this hypothesis.

The fall crop of McCormick potatoes furnished material for the experiments here recorded, except where otherwise noted. All the experiments, however, were repeatedly confirmed with the summer crop of both Green Mountain and Rehobeth potatoes. The regular mature crop of the McCormick potatoes was harvested November 4th. Tubers were at once planted in the greenhouse in soil, sawdust and sphagnum, but in no case did sprouting occur until January 18th; general sprouting did not begin until February. These results were confirmed by similar plantings of McCormick potatoes on three successive years. The rest period of McCormick potatoes under natural planting conditions is, therefore, about 90 days from the time the mature crop is harvested at this station. If they are harvested earlier the rest period is that much longer. Immature tubers harvested September 20th, and immediately planted in the greenhouse did not sprout until February 2nd.

Effect of Removing the Skin.—Simply removing the skin from potato tubers at any stage of the rest period will bring about sprouting within ten days, if favorable external conditions prevail. A number of methods were employed in order to supply the most favorable conditions for sprouting; but the best among those tried consisted in planting the stem ends in wet soil or sawdust and covering the seed ends with two or three inches of excelsior, kept constantly wet. This method exposes the terminal buds to the maximum partial oxygen pressure of the atmosphere. The mere greening of the tubers in the subdued light affords considerable protection against decay.

Under the above condition the degree of previous corking of the skin greatly influenced the length of time before the tubers with the skin intact began to sprout.

Tables 21 to 23 are typical experiments which show the above facts; see also figures 1 to 8. The temperature of each pot was recorded twice daily. The bulb of the thermometer was placed on a level with the terminal bud of the tubers. The variation among the different pots was always less than a degree. The average temperature one inch below the surface of the soil in pot 1, table No. 21, was 18.5°C. for the 135 days.

TABLE 21.

EFFECT OF REMOVING THE SKIN; IMMATURE TUBERS HARVESTED SEPTEMBER 20th AND PLANTED THE SAME DAY; 12 TUBERS IN EACH LOT.

Stem Ends Planted in	Seed Ends Covered with	Skins	Per Cent Sprouted After						Average Length of Sprouts After 35 Days
			10 Days	20 Days	35 Days	85 Days	110 Days	135 Days	
Soil	Soil	on	0	0	0	0	23	70	0
Soil	Excelsior	on	54	62	77	77	...	85	4mm
Soil	Excelsior	off	38	100	100	100	100	100	20mm
Sawdust	Sawdust	on	0	0	0	0	0	42	0
Sawdust	Sawdust	off	75	75	100	100	100	100	5mm
Sawdust	Sawdust	off	57	85	100	100	100	100	10mm

TABLE 22.

EFFECT OF REMOVING THE SKIN: MATURE TUBERS HARVESTED OCTOBER 28th AND PLANTED OCTOBER 31st: MEDIUM CORKED SKINS; 12 TUBERS IN EACH LOT.

Stem Ends Planted in	Seed Ends Covered with	Skins	Percent Sprouted After			
			10 Days	20 Days	35 Days	95 Days
Soil	Soil	On	0	0	0	16
Soil	Excelsior	On	0	0	20	100
Soil	Soil	Removed	0	0	25	82
Soil	Excelsior	Removed	25	83	100	100

TABLE 23.

EFFECT OF REMOVING THE SKIN; MATURE TUBERS HARVESTED NOVEMBER 4th AND PLANTED NOVEMBER 22nd; HEAVILY CORKED SKINS.

Stem Ends Planted In	Seed Ends Covered with	Skins	Per Cent Sprouted After			
			10 Days	20 Days	45 Days	72 Days
Sawdust	Excelsior	On	0	0	0	43
Sawdust	Excelsior	Removed	50	100	100	100

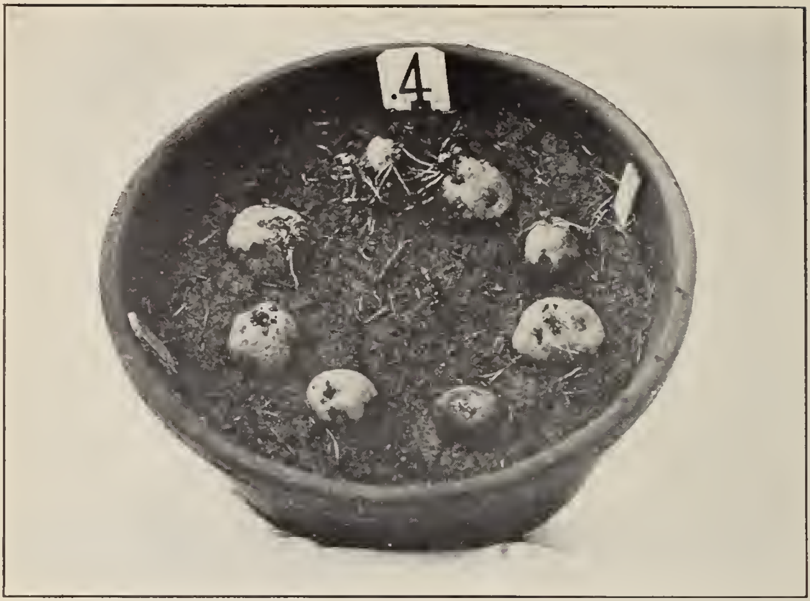

Fig. 1.—Skins removed; immature tubers harvested September 20th and planted the same day; sprouted under excelsior; photographed October 14th.

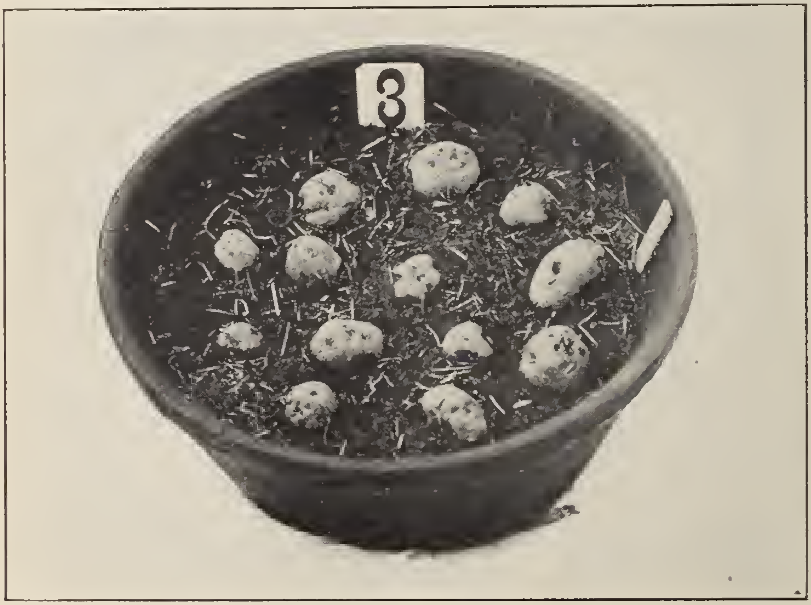

Fig. 2.—Skins not removed; check on pot 4, fig. 1.

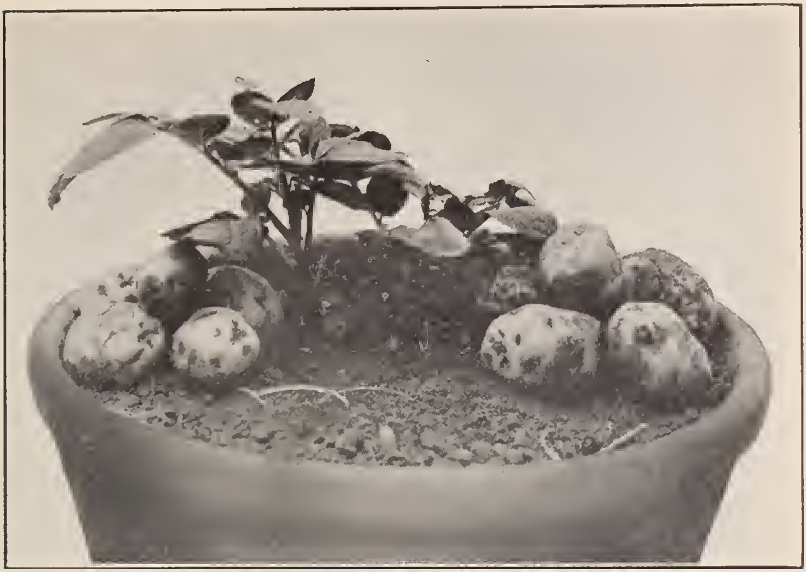

Fig. 3.—The plant is from one of the tubers sprouted with skins removed in pot 4, fig. 1. It was planted in this pot on October 15th. The tubers were of the same lot but planted with skins on in the soil of this pot on September 20th; they did not begin to sprout until January 20th; photographed December 4th.

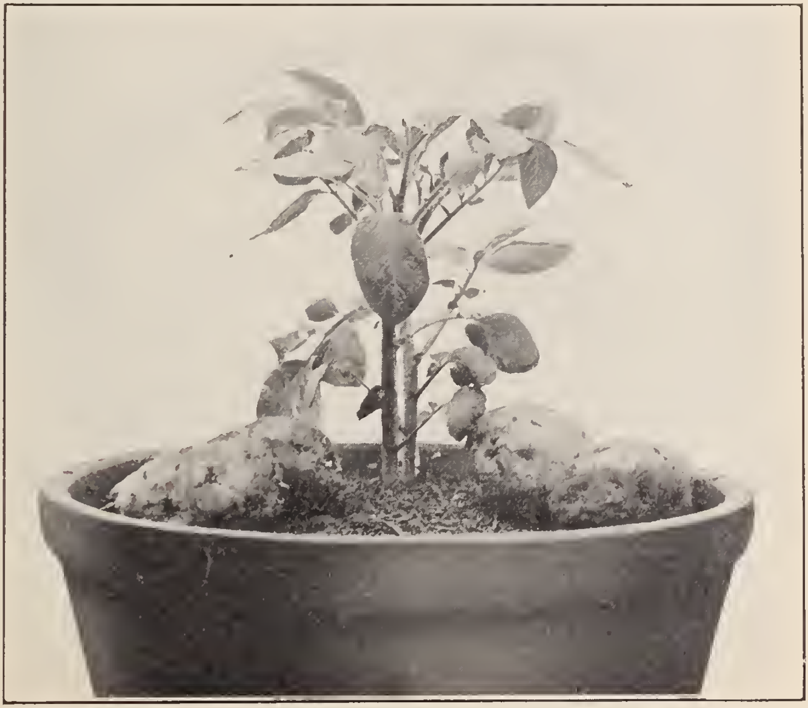

Fig. 4.—Plant from immature tuber harvested October 15th and sprouted with skin removed. The tubers on the left were sprouted at the same time, but planted in the soil before any roots were produced. Tubers on the right were planted in the soil with skins on; photographed November 24th.

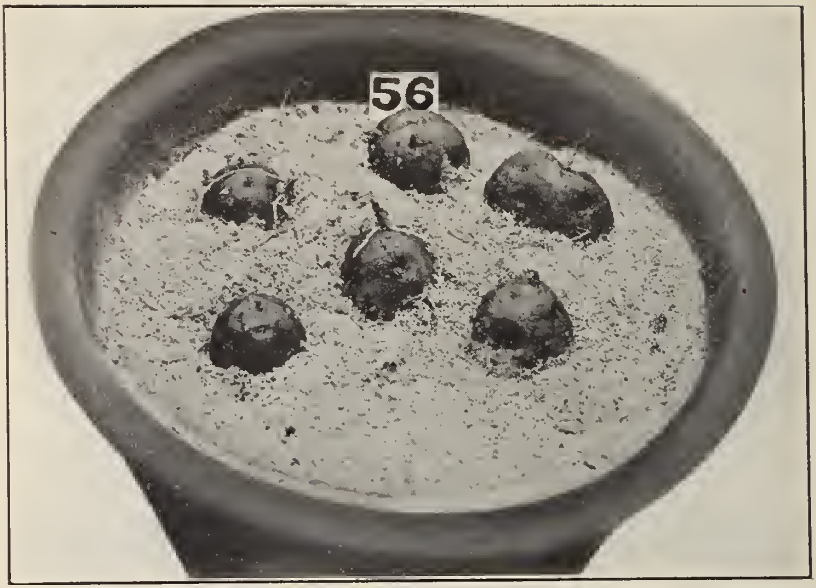

Fig. 5.—Skins removed; mature tubers harvested November 4th and planted November 22nd; heavily corked skins; stems ends in sawdust and seed ends covered with excelsior; photographed December 16th.

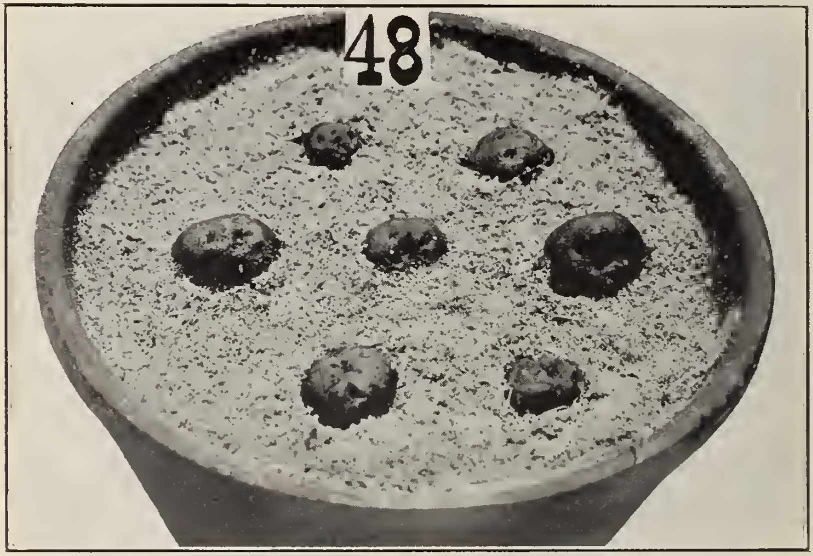

Fig. 6.—Skins not removed; check on pot 56, fig. 5. These tubers did not begin to sprout until January 27th.

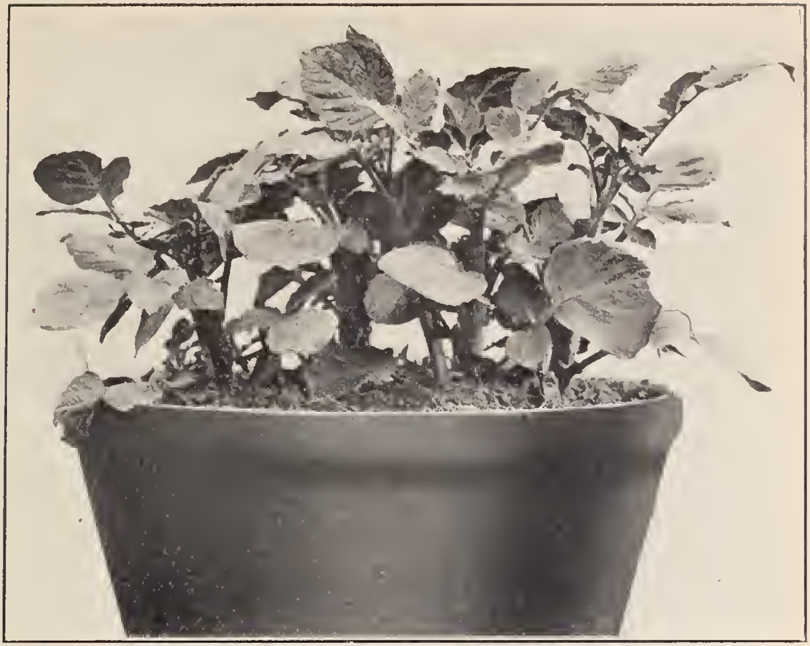

Fig. 7.—Plants from tubers in pot 56, fig. 5; photographed February 25th.

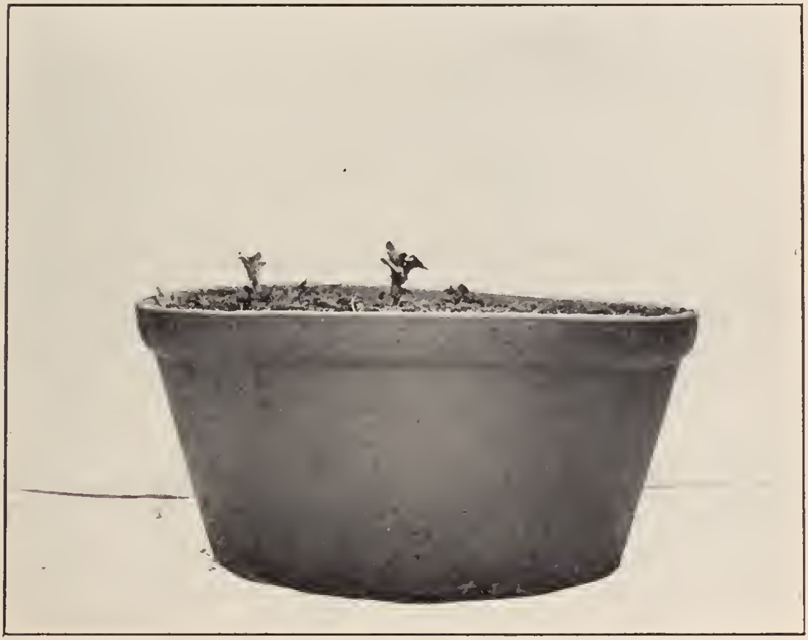

Fig. 8.—Plants from tubers in pot 48, fig. 6; photographed February 25th.

The elimination of the rest period by removing the skin is not due to water absorption from the exterior, as tubers with the skins removed will sprout even in dry storage much earlier than those with skins intact; see table 24 and figure 10.

TABLE 24.

EFFECT OF REMOVING THE SKINS AND STORING IN A DRY PLACE; MATURE TUBERS HARVESTED NOVEMBER 4th; SKINS REMOVED NOVEMBER 7th AND PLACED IN MOIST CHAMBER FOUR DAYS THEN IN PAPER SACKS STORED IN LABORATORY CUPBOARD.

Skins	Percent Sprouted after		
	45 Days	64 Days	85 Days
On	0	30	100
Removed	80	100	100

The figures showing the size of the plants produced during the rest period do not represent the maximum growth that could be obtained in the same length of time under more favorable growing conditions. No fertilizer of any kind was used and the temperature at times was below the optimum for growth.

Effect of Cutting the Tubers in Half.—All the experiments so far reported were conducted with whole tubers in which case sprouting always began first from the eyes on the seed end. The reverse, however, is true when the tubers are cut in half transversely to the long axis, separating the seed from the stem end. This applies only to tubers forced to sprout during the natural rest period. At the end of the rest period there seems to be little difference in respect to time of sprouting, between the eyes on the seed and stem ends if the tubers are cut in half.

On October 31st the skin was removed from tubers harvested October 28th. They were then cut in half. The halves were stood upright on wet soil and covered with wet excelsior. On November 15th all the stem halves bore sprouts from eyes located near the cut surface. Fig. 9 shows the growth of these sprouts on November 24th.

Two lots of four tubers each were selected from McCormick potatoes harvested November 4th. On November 8th the tubers were cut in four pieces in the manner shown in Fig. 11. In addition the skins were removed from the pieces in one lot; both lots were then placed on wet soil in pots and covered with excelsior which was kept constantly wet. Within ten days all the stem pieces with skins removed bore sprouts from eyes near the cut surface. The stem pieces with skins on began to sprout on the twentieth day. Figs. 11 and 12 show the growth of sprouts on the twenty-fourth day. It will be seen from this experiment that even with the skin intact, the buds near a cut surface begin to sprout much earlier than normally provided the exposed surface is kept moist and suberization thereby retarded. The buds on the pieces with skins removed not only sprouted still earlier, but the sprouts also grew much faster.

On November 13th tubers harvested November 4th were cut in half transversely to the long axis. The stem halves were then divided into two lots of five each. The cut surfaces of one lot were immediately dipped into warm paraffin. When the paraffin cooled, forming a thin layer over the surface, both lots were placed in paper sacks and stored in a dark, dry laboratory closet. On December 18th all of the paraffined halves bore sprouts from buds near the cut surface; see Figs. 13 and 14. The surface underneath the paraffin was still moist and the cell walls very little suberized. The paraffin in drying cracked from the edges sufficiently to allow free excess of air. The cut surfaces of those not dipped in paraffin were dry and heavily corked; these did not begin to sprout until a month later. It seems very probable that the surfaces kept moist by paraffin and not allowed to suberize admitted something to the nearby buds which was not so freely admitted through the heavily corked surfaces. It could not be water, as the sprouting occurred in a dry atmosphere. The other alternative is oxygen. The earlier sprouting in the case of the paraffined pieces was not the result of heat applied to the cut surface by the warm paraffin; this was proved when the experiment was repeated, using a third lot which was dipped in paraffin and the paraffin removed as soon as cold. This lot sprouted no earlier than the one not treated.

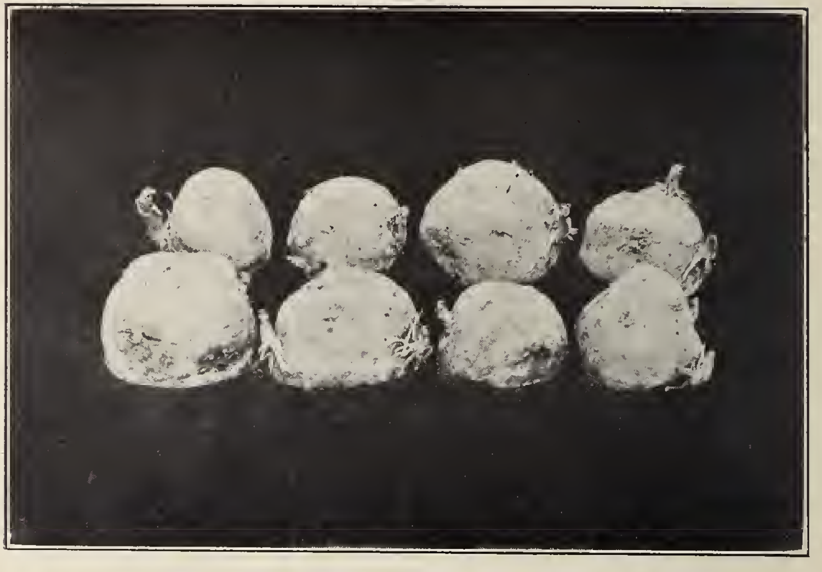

Fig. 9.—Skins removed; shows greatest growth from buds located near the cut surface; tubers harvested October 28th; experiment started October 31st; photographed November 24th.

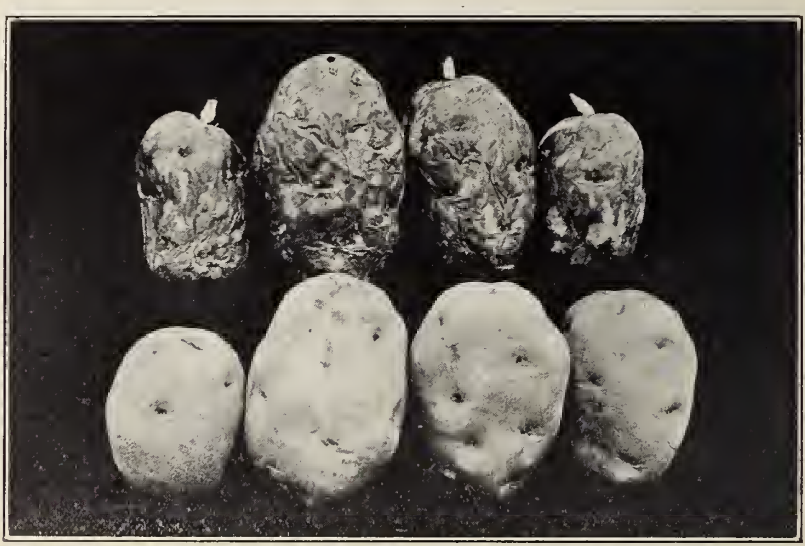

Fig. 10 shows earlier sprouting even in dry storage, if the skin is removed; tubers in upper row had skins removed November 7th; checks on lower row; tubers harvested November 4th; photographed January 6th.

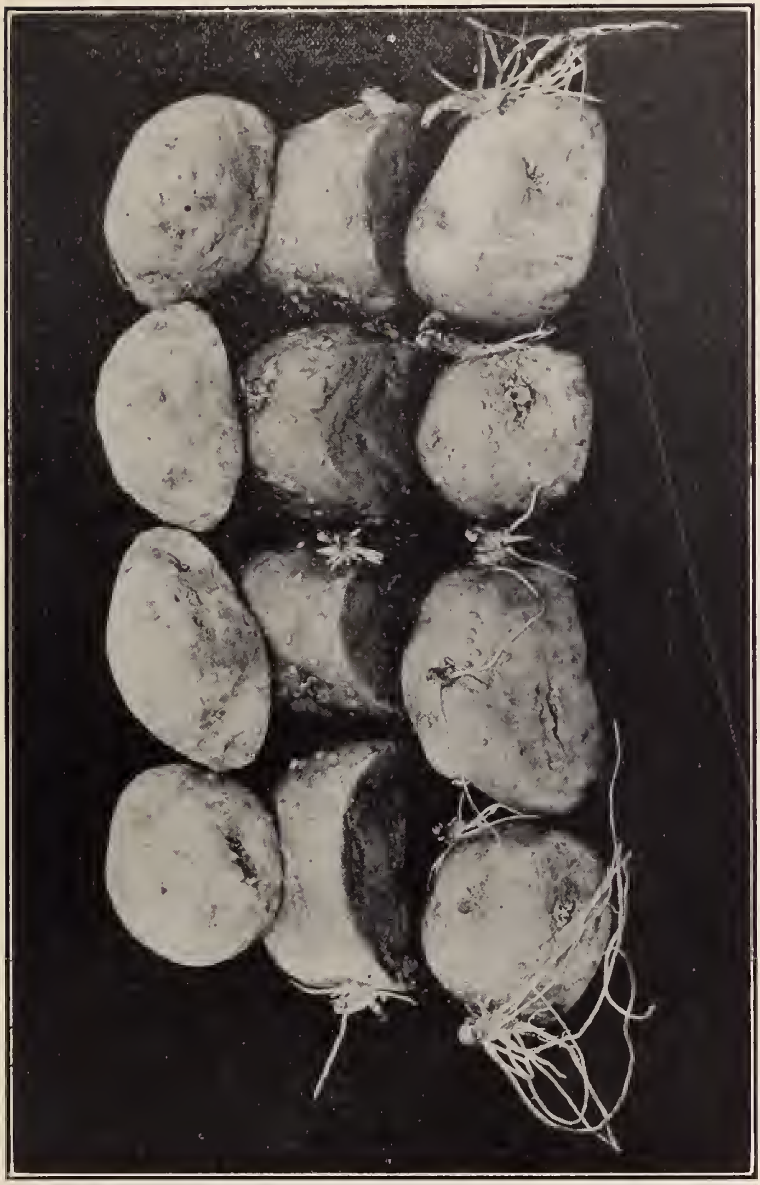

Fig. 11.—Skins removed; stem ends on bottom row; tubers harvested November 4th; experiment started November 8th; photographed December 5th.

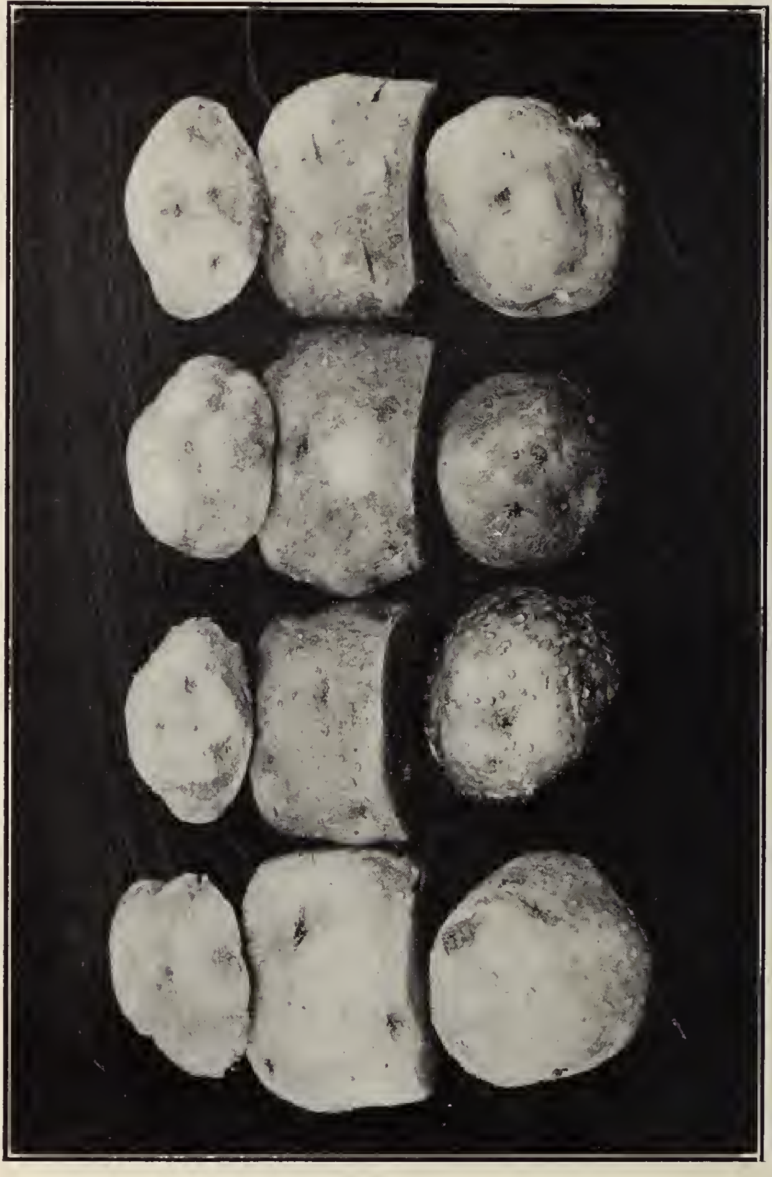

Fig. 12.—Skins not removed; check on Fig. 11; also shows early sprouting from buds on the stem ends located near the cut surface.

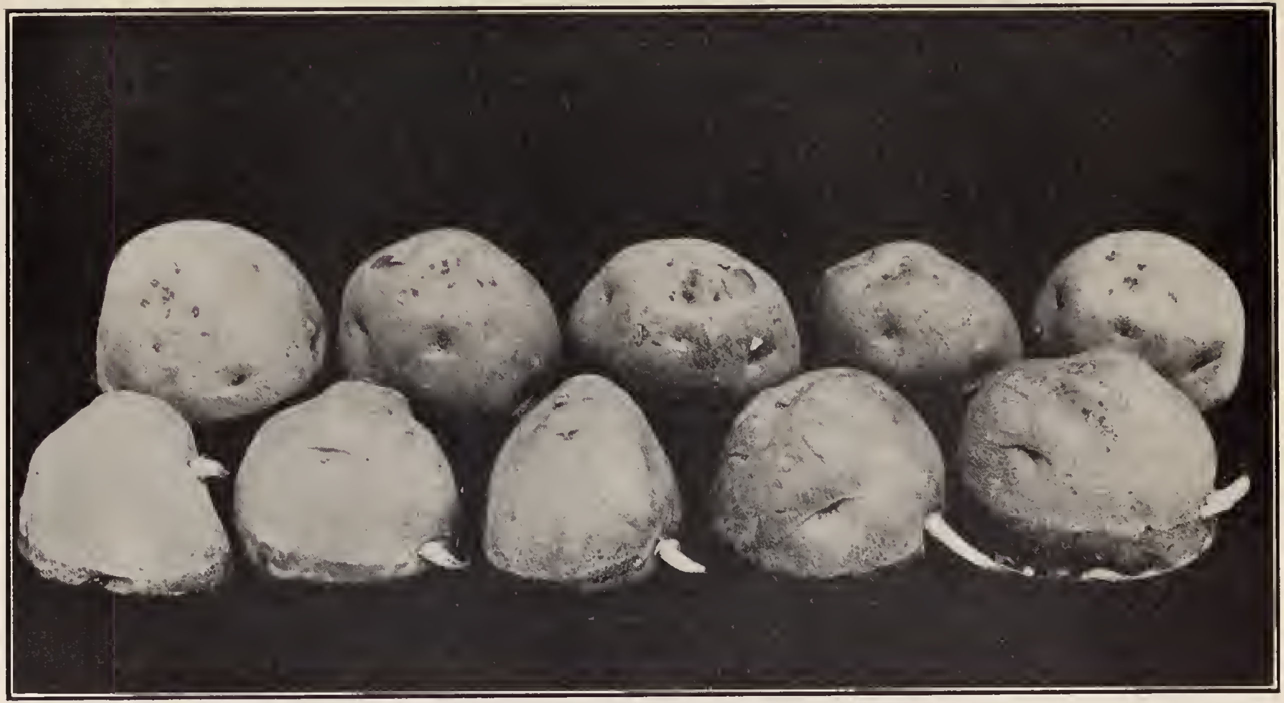

Fig. 13 shows sprouts from eyes located near the cut surfaces which were covered with paraffin to inhibit suberization of the surface cells; tubers harvested November 4th; treated November 13th and stored in a dry laboratory cupboard; photographed January 6th.

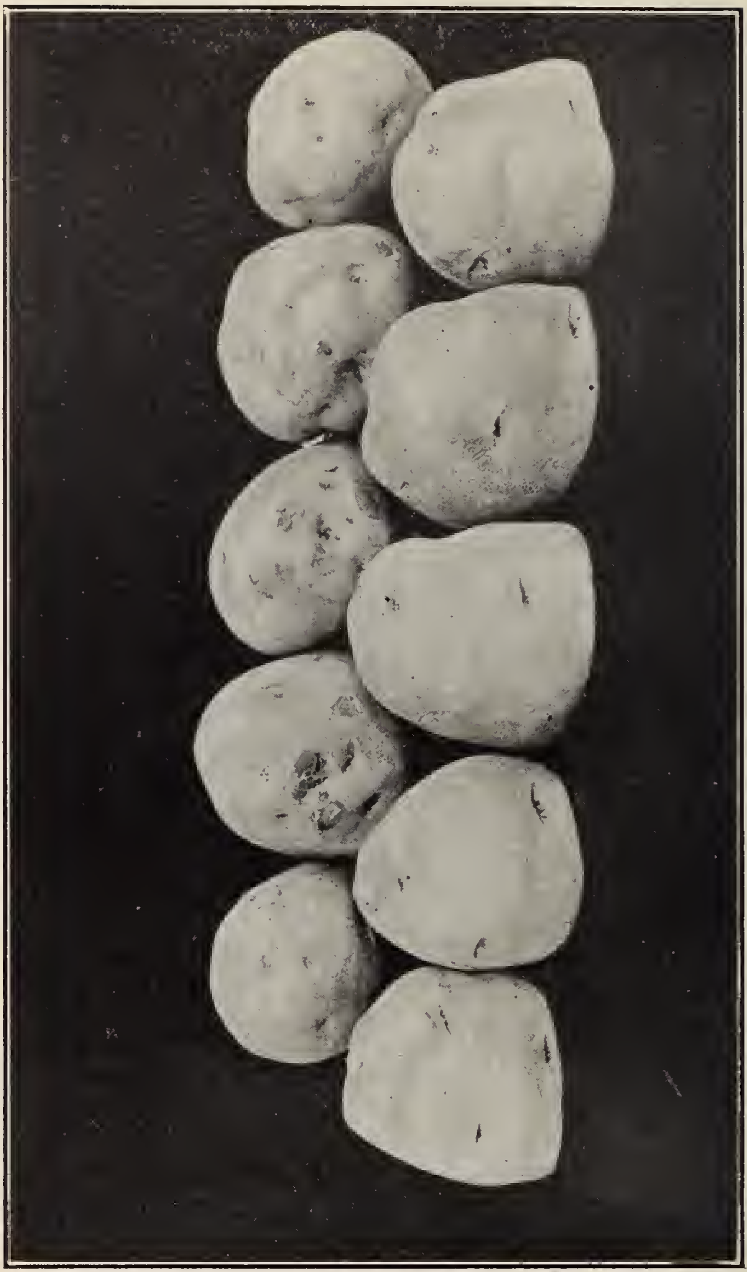

Fig. 14.—Cut surfaces not covered with paraffin; check on Fig. 13.

Effect of Light.—Planting tubers with the stem ends in soil and covering the seed ends with wet excelsior, exposes the latter to subdued light; it is sufficient, however, to induce rather rapid greening of the exposed part of the tuber. It soon became evident by the use of this method for sprouting tubers that light exercises an influence on the growth processes in the buds. Immature tubers with slightly suberized skins produce sprouts under the influence of subdued light and moisture almost as quickly as they do with the skins removed; see tables 21 and 25.

TABLE 25.

EFFECT OF SUBDUED LIGHT ON IMMATURE TUBERS WITH SLIGHTLY SUBERIZED SKINS; EIGHT TUBERS IN EACH LOT.

Seed Halves Covered With	Per Cent Sprouted After			
	20 Days	30 Days	40 Days	50 Days
Excelsior	43	43	51	100
Excelsior and Black Cloth...	0	0	14	43

The above light effect is entirely balanced when the skins are removed; for sprouting occurs just as early in the dark as in subdued light, other conditions being comparable.

TABLE 26.

EFFECT OF LIGHT WHEN THE SKINS ARE REMOVED; TWELVE TUBERS IN EACH LOT HARVESTED OCTOBER 28th AND PLANTED OCTOBER 31st.

Stem Ends Planted In	Seed Ends Covered with	Per Cent Sprouted After		
		10 Days	20 Days	35 Days
Soil	Excelsior and Black Cloth	25	83	83
Soil	Excelsior	25	83	100

Four lots of five tubers each were chosen from immature McCormick potatoes harvested September 20th and immediately planted in pots with the stem ends in the soil. The projecting seed ends of the four lots were covered as follows: (1) A double-walled bell glass filled with a solution of ammoniacal copper sulphate; (2) a like bell glass filled with a nearly saturated solution of potassium dichromate; (3) a clear bell glass; (4) a black walled bell glass. By means of bent tubes the air under the bells was in free communication with that on the outside. Through these tubes water was added daily to each pot in sufficient amounts to maintain under the bells a nearly saturated atmosphere. Equal quantities were added to each pot. Thermometers were placed inside the bell glasses and the temperatures recorded early in the morning and in the afternoon. The temperatures ran practically the same under all the bells except the clear one which showed an average of one to two degrees higher than the others.

TABLE 27.

EFFECT OF LIGHT ON SPROUTING; IMMATURE TUBERS WITH SLIGHTLY SUBERIZED SKINS.

STEM ENDS IN	SEED ENDS COVERED WITH	PER CENT SPROUTED AFTER			AVERAGE LENGTH OF SPROUTS AFTER 35 DAYS
		10 Days	20 Days	35 Days	
Soil	CLEAR BELL	100	100	100	8 mm.
Soil	RED BELL	20	100	100	5 mm.
Soil	BLUE BELL	0	0	20	1 mm.
Soil	BLACK BELL	0	0	0	0

The above experiment shows not only the stimulating effect of light on the growth processes in the buds, but also suggests that this effect is due to a greater oxygenation of the tissues by photosynthesis. The chief evidence for this hypothesis lies in the fact that the tubers under the blue bell glass sprouted very little earlier than those under the black bell glass. Although the tubers under the blue bell glass soon became green little photosynthesis would be expected on account of the slight energy for this process in the actinic rays.

Subdued light does not hasten the sprouting of tubers with well suberized skins; the effect is rather one of slight retardation.

The rest period of tubers with heavily suberized skins may be considerably extended by thorough greening in full light.

TABLE 28.

EFFECT OF SUBDUED LIGHT; MATURE TUBERS HARVESTED NOVEMBER 4th AND STORED IN A DRY PLACE FOUR DAYS BEFORE PLANTING.

STEM ENDS PLANTED IN	SEED ENDS COVERED WITH	PER CENT SPROUTED AFTER			
		20 Days	35 Days	74 Days	86 Days
Soil	Excelsior	0	20	75	100
Soil	Excelsior and Black Cloth	0	50	84	100

TABLE 29.

EFFECT OF SUBDUED LIGHT; MATURE TUBERS HARVESTED NOVEMBER 4th AND STORED IN A DRY PLACE 18 DAYS BEFORE PLANTING.

STEM ENDS PLANTED IN	SEED ENDS COVERED WITH	PER CENT SPROUTED AFTER			
		10 Days	20 Days	46 Days	72 Days
Soil	Excelsior	0	0	14	. . .
Soil	Excelsior and Black Cloth	0	0	67	100
Sawdust	Excelsior	0	0	0	43

Effect of Hydrogen Peroxide.—If the skin is in any degree permeable to hydrogen peroxide the abundance of catalase in potato tubers would decompose it, liberating free oxygen. Earlier sprouting would then be expected if oxygen is a limiting factor for growth under normal conditions. Experiments to test this hypothesis were conducted as follows: Tubers were wrapped in cotton saturated with dioxogen; then stored in moist chambers which were buried in wet sawdust underneath a greenhouse bench. Untreated tubers were planted in the sawdust just outside of the moist chambers. The sawdust was kept constantly wet.

TABLE 30.

EFFECT OF WRAPPING TUBERS IN COTTON SATURATED WITH HYDROGEN PEROXIDE; SIX TUBERS IN EACH LOT.

COTTON SATURATED WITH	100 PER CENT SPROUTED AFTER
3 Per Cent Dioxogen	28 Days
100 Per Cent Dioxogen	43 "
Untreated...........................	76 "

Table 30 is typical of a number of experiments that were performed with new potatoes. Such treatment failed, however, to shorten the rest period of tubers with heavily suberized skins; this alteration of the skin, doubtless, renders it impermeable to hydrogen peroxide. Numerous attempts to control these experiments by wrapping tubers in cotton saturated with distilled water usually failed on account of the decay of the tubers. It may be assumed, however, that the partial oxygen pressure in the wet sawdust would not be less than that under saturated cotton.

Effect of Anesthetics.—Various anesthetics have been found capable of setting into motion the growth processes in resting structures. The reported efficiency of ethyl bromide gas in the case of the potato tuber was confirmed. Ether gas had no effect in the single experiment in which it was tried.

Blocks about one centimeter square and bearing one eye each were cut from the seed end of McCormick potatoes and divided so that each lot contained six eyes from as many different tubers. The blocks were treated as indicated in the following table and planted in wet sawdust. By selecting the eyes from nearly the same region on each tuber and cutting from many different tubers the error due to bud variation in respect to the time of germination would be largely avoided, if such a variation existed. In most tubers there is a marked correlation in respect to time of sprouting between the buds on the seed end and those on the stem end, depending largely upon the vigor of the terminal bud or buds. By separate experiments, however, it was found that this correlation is destroyed where the eyes are cut out in the manner employed in this experiment. It may be assumed, therefore, that under normal conditions the buds would all germinate at about the same time.

TABLE 31.

EFFECT OF ETHYL BROMIDE GAS; BLOCKS PLANTED NOVEMBER 15th.

Blocks Exposed to Ethyl Bromide Gas	Per Cent Sprouted on					
	Dec. 12	Dec. 22	Jan. 4	Jan. 15	Jan. 25	Jan. 27
2 Minutes	0	0	50	50	50	100
4 Minutes	0	0	100	100	100	100
5 Minutes	17	83	83	100	100	100
10 Minutes	0	20	100	100	100	100
20 Minutes	0	0	100	100	100	100
Untreated	0	0	0	0	0	100

TABLE 32.

EFFECT OF ETHYL BROMIDE GAS; SIX TUBERS IN EACH LOT.

Whole Tubers were Exposed to Ethyl Bromide Gas	Date when First Tuber Sprouted	Date when Last Tuber Sprouted
30 Minutes	December 20	January 20
15 Minutes	January 14	....
Untreated	January 18	January 28

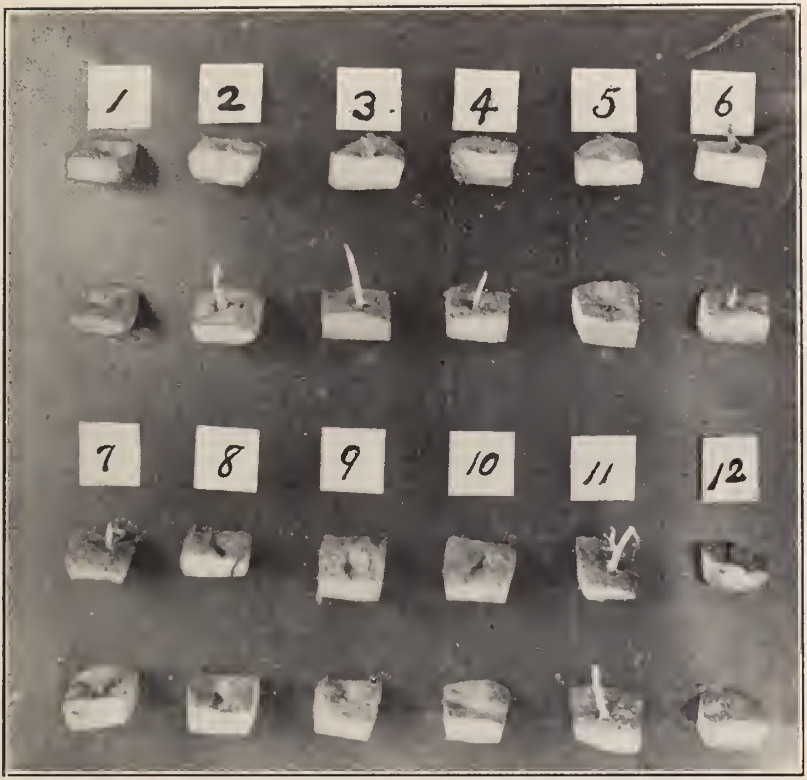

Fig. 14.—Two blocks were chosen from each lot in table 31 and photographed January 4th. They represent the maximum and minimum growth of sprouts in each lot. 1, untreated; 2, skins removed; 3, exposed to ethyl bromide gas five minutes; 4 exposed to ethyl bromide gas ten minutes; 5, exposed to ethyl bromide gas two minutes; 6, exposed to ethyl bromide gas four minutes; 7, exposed to ethyl bromide gas twenty minutes; 8, exposed to ether gas five minutes; 9, exposed to ether gas ten minutes; 10, heated in moist chamber at 40 C. for four days; 11, heated in moist chamber at 40°C. for eight hours; 12, heated in dry air at 40C. for eight hours.

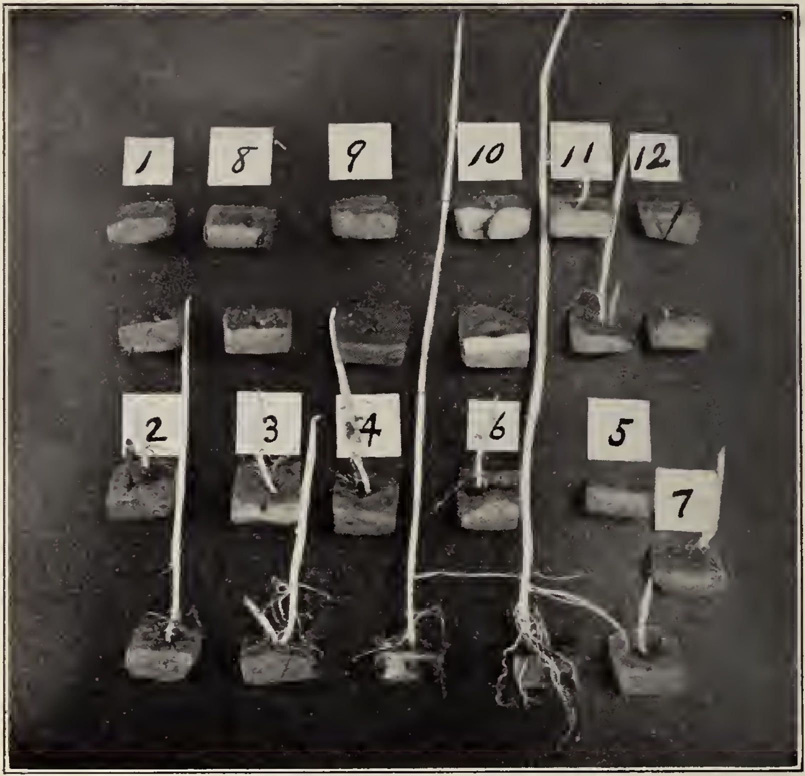

Fig. 15.—A later photograph of the same blocks shown in Fig. 14.

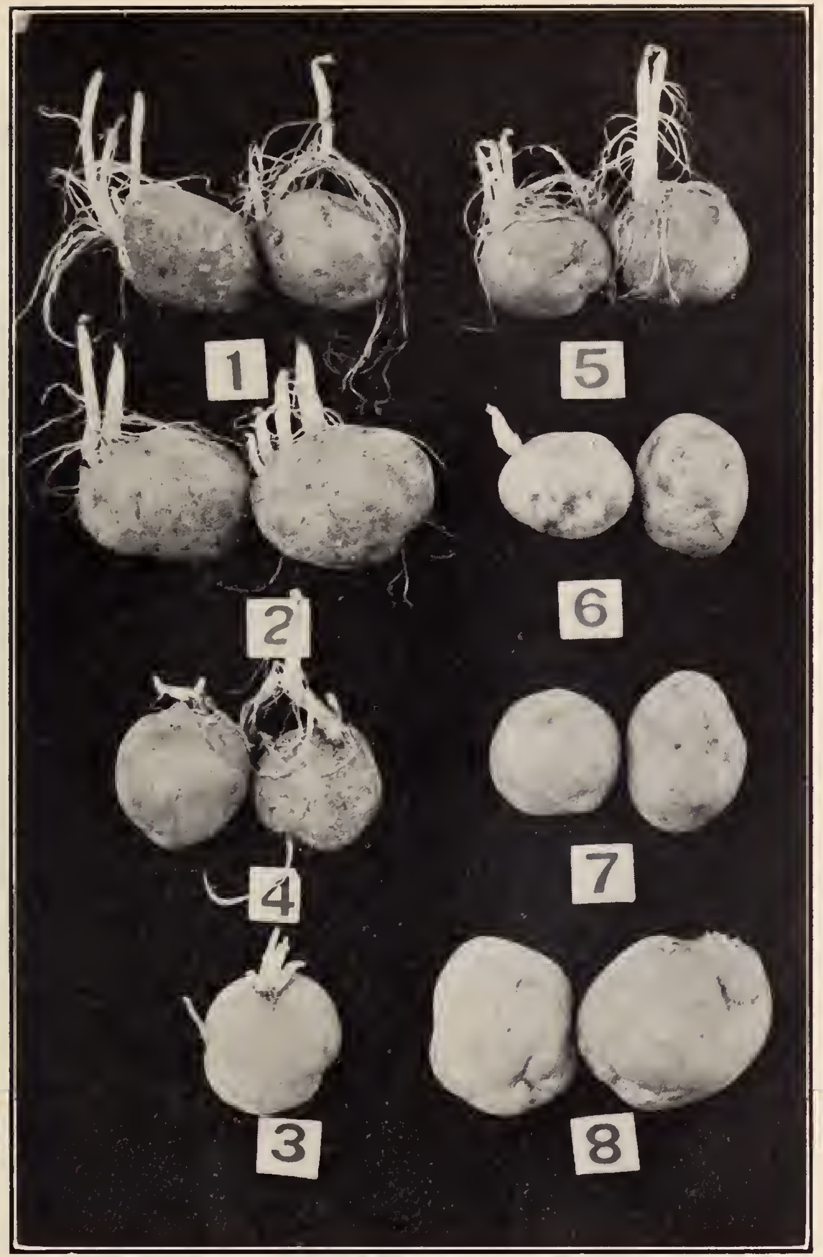

Fig. 16.—Green Mountain potatoes harvested November 4th; treated November 13th and planted in wet sawdust. 1, skins removed; 2, skins removed four weeks later than 1; 3, wrapped in cotton saturated with full strength dioxygen until December 3 (all decayed by one); 4, wrapped in cotton saturated with 3 percent dioxygen and kept in moist chamber throughout the experiment; 5, exposed 30 minutes to ethyl bromide gas; 6, exposed to ethyl bromide gas 15 minutes; 7, thoroughly greened in full greenhouse light; 8, checks. Two tubers were chosen to show the maximum and minimum growth of sprouts in each lot of six tubers and photographed January 21st.

Note.—This was an early experiment and the tubers were not sprouted under the more favorable conditions discovered later. However, the experiment shows the relative growth under the various treatments as they were all sprouted under the same conditions, except the tubers treated with the 3 percent dioxygen. These tubers were kept in a moist chamber which was set on top of the sawdust.

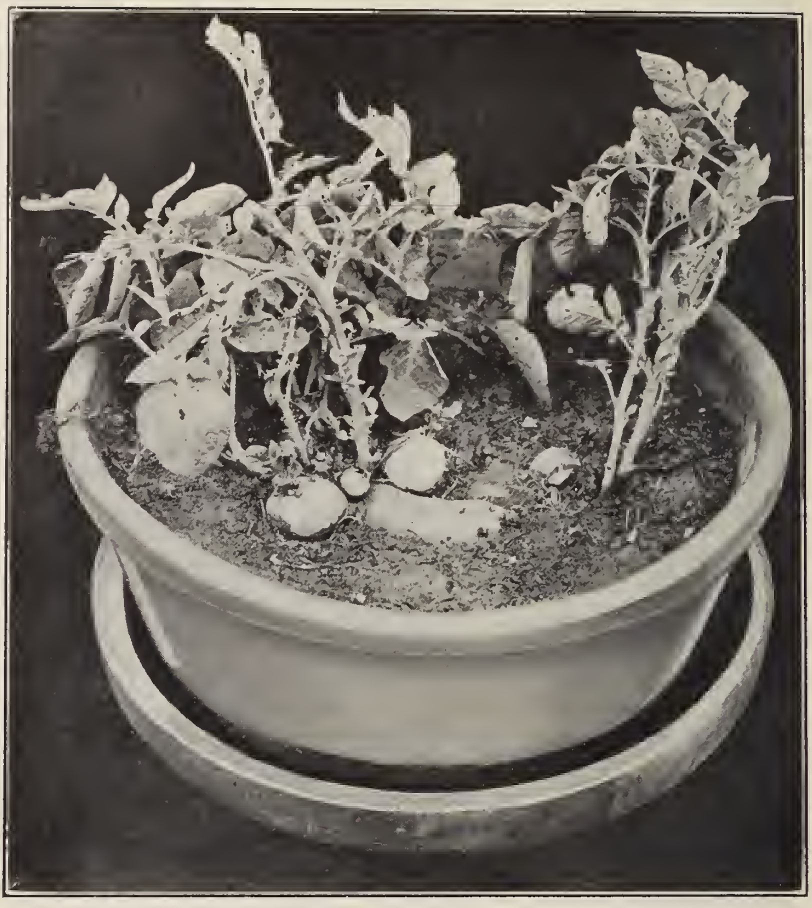

Fig. 17 shows the complete elimination of the rest period of Early Rose potatoes. The new tubers were partly exposed to the air, but were well shaded by the vines of the parent plant. The pot stood outdoors in midsummer and was heavily watered daily, keeping the exposed part of the tubers moist most of the time. Photographed June 27th.

The character of the sprouts produced under the various treatments and the problem of growing normal plants from these sprouts during the rest period will be considered in a future paper dealing with some practical application of the principles here set forth.

Respiration.—It has been shown that the rest period of potato tubers can be either entirely eliminated or greatly shortened by means which would seem to facilitate the oxygenation of the internal tissues. That a great increase in oxygen absorption actually occurs is proved conclusively by the effect of the various treatments on respiration; the rate of which was determined by the amount of carbon dioxide expired from the tubers. Ten tubers, with a total weight of about

1,500 grams, were used for each determination which was allowed to run 24 hours at room temperature. The control determinations were made at the same time and under exactly the same conditions. The apparatus employed is fully described by Gore (15). Kuster's (25) method was used for the estimations of the carbon dioxide in the sodium hydroxide solution.

The amount of carbon dioxide expired from new potatoes with thin, slightly suberized skins is much greater than that from the same tubers after the skins have become well corked and adherent to the underlying tissues. When the latter character of the skin is attained the rate of respiration under uniform conditions remains fairly constant until the beginning of sprouting. Table 33 is a typical experiment which will suffice to show this fact. Immature Rehobeth potatoes grown in the greenhouse and harvested January 21st furnished the material for this experiment. The tubers were stored in a dry, warm laboratory drawer.

TABLE 33.

RELATION OF RESPIRATION TO SKIN SUBERIZATION.

DATE OF DETERMINATION	THERMOGRAPH AVERAGE OF ROOM TEMPERATURE	MILLIGRAMS OF CO 2 PER KILO PER HOUR
January 21	20.3 C	24 7
January 26	20. C	22.4
February 2	21.1 C	12.3
February 26	22.2 C	8.26
March 3	22. C	8.08

Removal of the skin from mature tubers or hacking the entire surface of the tuber with a knife more than doubles the rate of respiration; it falls again with the formation of a new thoroughly corked skin to that of unpared tubers.

TABLE 34.

EFFECT OF REMOVING THE SKIN.

DATE OF DETERMINATION	MILLIGRAMS OF CO_2 PER KILO PER HOUR		RATIO
	Untreated	Skins Removed	
November 7	14.94	34 7	1:2.32
November 10	12.02	26.37	1:2.19
December 2	10.9	11.8	1:1.08

TABLE 35.

EFFECT OF HACKING THE ENTIRE SURFACE OF THE TUBER WITH A KNIFE.

DATE OF DETERMINATION	MILLIGRAMS CO_2 PER KILO PER HOUR		RATIO
	Untreated	Wounded	
November 21........	18.41	51.83	1:2.80
January 8...........	5.34	6.47	1:1.21

Exposing the tubers to ethyl bromide gas has about the same accelerating effect on respiration as removing the skin.

TABLE 36.

EFFECT OF TREATMENT WITH ETHYL BROMIDE GAS.

DATE OF DETERMINATION	MILLIGRAMS OF CO_2 PER KILO PER HOUR		RATIO
	UNTREATED	ETHYL BROMIDE GAS—30 MINUTES	
January 18...........	7.26	28.54	1:3.93
January 21...........	7.08	27.85	1:3.83

It has been shown that the rest period can be shortened by wrapping the new tuber in cotton saturated with hydrogen peroxide. This treatment also accelerates the rate of respiration in new tubers.

TABLE 37.

EFFECT OF TREATMENT WITH HYDROGEN PEROXIDE; NEW TUBERS.

EXPERIMENT	MILLIGRAMS OF CO_2 PER KILO PER HOUR		RATIO
	Lot 1	Lot 2	
1	Untreated 22.41	Untreated 24.65	1:1.10
2	Wrapped in Sterilized Cotton Saturated with Sterilized Water 22.9	Wrapped in Cotton Saturated with 50 per cent. Dioxogen 39.3	1:1.72

It is obvious that the elimination or abbreviation of the rest period under the conditions employed in this work is correlated with greater oxygen absorption. It does not necessarily follow, however, that sprouting was brought about by the greater energy release resulting from the increased respiration. The facts seem to indicate that this was not the case. It is more probable that under normal conditions the skin becomes suberized before the completion of some growth mechanism requiring oxygen. The rate of oxygen diffusion through the suberized skin then determines the time—the natural rest period—required for the perfection of the growth mechanism.

The role of oxygen in plant physiological process is very complex and at the present time quite obscure. However, several cases are noted in the literature which show the wide range of oxygen influence in growth processes. Ivanoff (20) claims that oxygen is necessary for the transformation of zymogen into zymase. Zaleski (56) has shown that protein synthesis is influenced by oxygen, etc.

SUMMARY AND CONCLUSIONS.

Under normal planting conditions potato tubers will not sprout for several weeks after harvest. During this rest period certain changes must occur in the chemical or physical situation of the buds or their immediate environment which are essential to the release of the growth processes. These changes are spoken of as "after-ripening," using the term in its broadest sense.

The carbohydrate transformation during the rest period are dependent entirely upon changing temperature.

Active diastase and invertase are present at all stages of the rest period, but show no increase under normal growing conditions until the tubers begin to sprout.

The juice from tubers at the end of the rest period causes a greater acceleration of the oxidation of pyrogallol than the juice from new immature tubers of the same variety. The seed and stem halves show no difference in the ability to oxidize pyrogallol even after sprouting from the seed end.

After-ripening does not involve protein hydrolysis. There is no change during the rest period in the relative magnitudes of the following forms of nitrogen: Proteose and peptone; diamino acids and other bases; mono amino acids and amides.

Protein, lipoid, organic extractive and inorganic phosphorus calculated to percent of total phosphorus, each remain constant up to the time of sprouting.

The magnitudes of the substances studied are not all identical in the seed and stem halves. The relative composition, however, remains practically constant during the rest period in spite of fact that sprouting begins much earlier on the seed end.

Metabolic changes involving the above forms of nitrogen and phosphorus begins rather suddenly and are concurrent with sprouting. The same is true of diastase.

Drying causes rapid suberization of new skin and exposed surfaces.

Suberization greatly reduces the permeability of the skin to water and gases.

Potatoes may be sprouted at any time during the rest period by simply removing the skins and supplying the tubers with favorable growing conditions, which includes in this case the maximum partial oxygen pressure of the atmosphere. The elimination of the rest period by this means is not due to water absorption from the exterior as tubers with skins removed will sprout even in dry storage much earlier than those with skins intact.

If tubers are cut in half transversely or cut into half-inch slices the buds on the stem half located near the exposed surface will sprout much earlier than normally, provided suberization of the surface cells is prevented. This may be accomplished by laying them on wet soil or better sawdust and covering with wet excelsior. Sprouting in this case also was not due to water absorption because the rest period of these buds may be greatly shortened in dry storage if drying of the exposed surface is prevented by covering it with a thin layer of paraffin.

The earliest sprouting occurred when the skins were removed and the tubers also cut in the above manner.

Subdued light stimulates growth in buds on new tubers with slightly suberized skins. The evidence at hand makes it highly probable that this effect is due to greater ozygenation of the tissues by photosynthesis. The light influence entirely disappears when the skin is removed.

Subdued light does not stimulate growth in the buds on tubers with highly suberized skins; the effect is rather one of slight retardation.

The rest period of new potatoes may be shortened by wrapping the tubers in cotton saturated with hydrogen peroxide. The abundance of catalase in the potato tuber, decomposes the hydrogen peroxide diffusing through the thin skin, liberating free oxygen. This treatment had no effect on old tubers on account of the impermeability of the heavily suberized skin to the hydrogen peroxide.

The efficiency of ethyl bromide gas in setting into motion the growth processes in resting buds of the potato tuber was confirmed.

All the above treatments greatly accelerate the rate of respiration. It may be safely concluded, therefore, that the elimination or abbreviation of the rest period under the conditions employed in this work is correlated with increased oxygen absorption.

The rest period of the potato tubers is not firmly fixed and hereditary. It is not of internal origin due to autogenic metabolic changes, as it can be entirely eliminated by means which maintain a proper adjustment between the bud tissue and external agents, chiefly oxygen. In nature the oxygen supply to the internal tissues is regulated by skin characters which are greatly influenced by moisture relations.

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THE MARYLAND AGRICULTURAL
EXPERIMENT STATION

BULLETIN No. 184 JUNE, 1914

THE PHYSICAL CHARACTER OF THE CURD OF MILK FROM DIFFERENT BREEDS. CURD AS AN INDEX OF THE FOOD VALUE OF MILK. STUDIES OF THE PROTEID CONTENT OF MILK.

By S. S. Buckley.

Cows milk is a faintly acid fluid composed of globules of fat, caseinogen, albumin, milk sugar, cellular elements, inorganic salts and water.

Most divergent opinions have been advanced to account for the formation of these products, and none is satisfactory in explaining the origin of all. In the study of the secretion of milk it must be remembered that the udder assumes two phases—the lactating or active, and the non-lactating or resting phase.

Arterial blood supplies to the udder its sole source of gain, while venous blood, lymph and milk represent the total sources of loss to that organ. However, it must be remembered that blood is supplied to the udder through the same afferent vessels, and the blood and lymph are returned from the udder through the same efferent vessels in the non-lactating as in the lactating udder. In the lactating udder, however, the secretion of milk results. What, therefore, occurs in the function of milk secretion?

The constituents of milk, peculiar to that fluid, are caseinogen, milk sugar and butter fat. While fat occurs in the blood, as such, its character and its small amount do not explain the presence of butter fat in the milk. Neither caseinogen nor lactose occurs normally in the blood. Milk cannot, therefore, be regarded as a mere transudation of blood products, but must be regarded as a product of cell activity in the mammary glands, through the activity of the alveolar cells chiefly. On the other hand, the products of secretion of the mammary gland are so closely related to existing substances in the blood that transformation only seems necessary and we may, therefore, safely regard milk constituents as true products of metabolism.

The first material secreted by the mammary gland upon becoming active is known as Colostrum. An analysis by Engling of such secretion from a cow eight years of age is here given.

Time after Calving.	*Spec. Grav.*	*Fat.*	*Casein.*	*Albumin.*	*Sugar.*	*Ash.*
Immediately	1.068	3.54	2.65	16.50	3.00	1.18
After 10 hours......	1.046	4.66	4.28	9.32	1.42	1.55
After 24 hours......	1.043	4.75	4.50	6.25	2.85	1.02
After 48 hours......	1.042	4.21	3.25	2.31	3.46	0.96
After 72 hours......	1.035	4.08	3.33	1.03	4.10	0.82

The secretion contained 16.56% of albumin immediately after calving, which in the course of 72 hours was reduced to 1.03%. Albumin of Colostrum, according to Allen, appears to be identical with albumin of the blood. Leclainche, Vallee and Mertens, however, in the studies of precipitins, have shown that the albumins of the blood and those of milk are different, and the presence of albumin in milk is probably the result of the secretory activity of the cells of the gland and cannot be regarded as a transudation product.

We find that Caseinogen is present from the beginning of secretion in approximately normal amounts, existing to the extent of 2.65% immediately, and 3.33% seventy-two hours after calving. Caseinogen is the product of ferment activity upon the albumin derived from the blood. (Meade Smith.)

The fat of colostrum differs from the fat of milk in being more oily. This difference is apparently due to the variation of the inorganic salts which occurs in the change from the colostrum secreting to the true milk secreting period.

The sugar of colostrum appears to be identical with dextrose, and but little lactose is present. With the occurrence of milk free of colostrum the true lactose becomes evident.

Colostrum corpuscles are leucocytes which have undergone complete fatty degeneration without disintegration. They exist in considerable numbers in the beginning of lactation, but disappear almost completely in from 12 to 14 days.

Milk—Composition.

Normal cows milk has a fairly definite chemical group composition. Variations occur in the proportions of the constituents of milk from the same individual at different times during the same lactation period, in the milks of different individuals of the same breed and in the milks of cows of different breeds. When there are variations appearing in the character of the constituents, however, we must regard such milks as abnormal.

The proportion of the constituents of milk as shown by an average analysis of 172,093 samples, according to Allen's Commercial Organic Analysis, is

Fat	4.02
Solids, not fat	8.84
Total solids	12.86
Water	87.14
Total	100.0

A more extended analysis shows that milk of good average quality contains

Fat	4.00	Milk sugar	4.75
Casein	3.00	Ash	0.75
Albumin	0.50	Water	87.00

Even in this extended analysis we must regard the constituents as representing classes, rather than specific compounds.

Fat.—Butter fat exists in milk as a compound of the Glyceryl Salts of fatty acids.

The solid portion of the fat is considered by Blyth and Robertson to be the compound

$$\text{Glyceryl } C_3H_5 \left\{ \begin{array}{l} C_4H_7O_2 \text{ (butyrate).} \\ C_{16}H_{31}O_2 \text{ (palmitate).} \\ C_{18}H_{33}O_2 \text{ (oleate).} \end{array} \right.$$

Besides these, there are fatty acids present which are soluble in the serum of milk, and more or less variable in composition. Variations in composition occur in the course of the period of lactation, as a result of different foods and with the changes in the physical condition of the cow.

Fat is observed in milk as microscopic globules, in size varying from 0.010 mm. to less than 0.0016 mm. in diameter. In freshly drawn milk these globules are suspended in the serum as an emulsion, which gradually rise to the surface, on setting, as cream. The globules do not coalesce, but remain separate and distinct, unless alterations occur in the other constituents. They then coalesce or undergo decomposition changes. When no alterations have occurred in creaming the fat may be re-distributed throughout the milk. There are, however, exceptions to this and re-emulsification is impossible. Such creams are referred to as "leathery."

As the period of lactation advances the number of large globules becomes less and the number of small globules becomes greater.

The four principal dairy breeds are naturally separated into two classes by the size of the fat globules. The Holstein and Ayrshire breeds furnish milk in which the fat globules are small and bear a close relationship to each other, while the Jerseys and Guernseys form a separate class, having larger globules.

Average Size of Fat Globules in Milk.

	Buckley.	*Gilbert.*	*New York (Geneva) Sta.*
Holstein	0.00256 mm.	0.0020 mm.	0.0021 mm.
Ayrshire	0.00257 mm.	0.0021 mm.	0.0020 mm.
Guernsey	0.00354 mm.	0.0026 mm.	0.0027 mm.
Jersey	0.00364 mm.	0.0028 mm.	0.0026 mm.
Mule (one animal)	0.00275 mm.	....	....
Human	0.00345 mm.	0.0029 mm.	....

Caseinogen and Albumin.—It is desirable for many reasons to consider these two proteids together in milk discussions. Chemists differ in regard to what the nature of the proteid content of milk is, yet there is greater unanimity of opinion in accepting the existence of three distinct compounds—caseinogen, albumin and globulin. Whether or not chemical analyses indicate a mixture of proteids, there are evidences of differences presented in the reactions which minute amounts of milk show when brought into contact with chemical reagents. The milks of different species of animals vary in the character of their proteids quite as distinctly as they do in regard to the other components.

It has been pointed out already that the first secretion of the gland—Colostrum—contains large quantities of albumin, 11.18 to 20.21%; and according to Allen, the albumin of colostrum is aparently identical with the albumin of the blood. Blood albumin, however, is regarded as a mixture of at least three albumins, according to Kander and Halliburton. These varieties they indicated by the results of fractional coagulation by heat. The differences were constant in the blood of a number of species, including man. In the horse, ox and sheep only two varieties could be detected and in the cold-blooded animals only one variety appeared to exist. The other blood proteids, Fibrinogen and Serum-globulin, coagulated at constant temperatures, differing from each other and from the several varieties of serum-albumins.

Fibrinogen probably is never present normally in milk, and when recognized, as Fibrin, is to be regarded as a pathological indication.

Albumin exists in milk in the earliest stages of lactation in large amounts (16.00%). When the alveolar epithelium begins to function normally, Caseinogen, a proteid peculiar to milk, is formed and the quantity of albumin is materially reduced (1.00%). It is the proteid Caseinogen alone that is acted upon by Rennet and the resulting product is Casein. Casein then is coagulated caseinogen and it cannot be restored to the soluble form. Caseinogen, however, may be precipitated by acids and later restored to solution by neutralization. Precipitated caseinogen is coagulated into the casein form by boiling, while it is not thus coagulated from the soluble from in which it exists in milk.

Globulin may be transuded from the blood plasma in the small quantities in which it exists in milk, but its presence can as well be accounted for from the disintegration of the leucocytes, which is constantly occurring in normal milk secretion.

Neither albumoses nor peptones have been detected in normal blood, though both occur in small amounts in milk.

PROTEID REACTIONS WITH PRECIPITATING REAGENTS.

In the following discussion of the behavior of proteids when brought into contact with precipitating reagents, it must be borne in mind that no effort was made to determine the identity of the precipitates, but merely to note constant differences with the idea of measuring variations which the milks of cows of different breeds possessed.

Reagents.—Excess of strong alcohol coagulates proteids (except peptones and albumoses).

Picric Acid precipitates proteids very completely in milk slightly acidulated with Acetic Acid. Mucin is precipitated as well, but without the addition of Acetic Acid it is not thrown down.

Almen's reagent precipitates proteids completely.

Weak mineral acids precipitates proteids incompletely.

Ammonium Sulphate will precipitate all proteids but peptone from neutral solutions, but these return to solution when the reagent has been washed away.

Moderate treatment with alcohol precipitates albumin and globulin. This precipitate is soluble for a short time in water, but long contact with alcohol results in complete coagulation. Albumoses and peptones are precipitated but not coagulated by this treatment.

The above reagents were used in the comparison of proteids in samples of milk of different breeds and species and the results indicate differences of importance.

Technic.—The addition of any precipitating reagent to samples of milk already opaque does not afford an opportunity for comparison of the resulting precipitates. Furthermore, the strength of the reagent is modified by the water of the plasma of the milk to such a degree that fractional separation of proteids by varying strengths of the reagent is impossible. It was, therefore, found desirable to bring the milk and the reagent together in such a manner that both of these objections would be overcome. This was successfully done by adding the sample of milk in minute amounts to the reagent by means of a separating funnel set to discharge by drops.

The principal series of tests was made with dilute hydrochloric acid as the precipitating reagent in 15 cc. amounts and of varying strengths. Into this single drops of milk were discharged from a constant height and at uniform temperatures.

It was found necessary to use symbols to designate the different apearances of the precipitates and those used are here given with their equivalent meanings.

O= negative; i. e., no precipitate whatever.
⊖= a mere trace.
—= slight.
±= positive, yet incomplete.
+= positive, completely by hydrochloric acid.

The hydrochloric acid was used in a series of dilutions which were prepared in bulk as follows:

No. 1	contained.......	5 cc.	HCl	(m. w. 36.5)	+2000	cc.	water
2	contained.......	10 “	“	+	“ “	“	“
3	contained.......	15 “	“	+	“ “	“	“
4	contained.......	20 “	“	+	“ “	“	“
5	contained.......	25 “	“	+	“ “	“	“
6	contained.......	30 “	“	+	“ “	“	“
7	contained.......	35 “	“	+	“ “	“	“
8	contained.......	40 “	“	+	“ “	“	“
9	contained.......	45 “	“	+	“ “	“	“
10	contained.......	50 “	“	+	“ “	“	“
11	contained.......	55 “	“	+	“ “	“	“
12	contained.......	60 “	“	+	“ “	“	“
13	contained.......	65 “	“	+	“ “	“	“
14	contained.......	70 “	“	+	“ “	“	“
15	contained.......	75 “	“	+	“ “	“	“
16	contained.......	80 “	“	+	“ “	“	“
17	contained.......	85 “	“	+	“ “	“	“
etc., up to	....	100 “	“	+	“ “	“	“

A set represents a series of beakers containing 15 cc. each of the above dilutions of hydrochloric acid. The reactions it must be remembered result from contact of a single drop of milk with the 15 cc. HCl dilution and they range from negative to positive. In the course of the work it developed that the alternate strengths could be dispensed with and those usually employed were those containing 10 cc. and the multiples of 10 of the HCl.

The following tables show the results obtained with milks from the four principal dairy breeds.

TABLE 1—Holsteins.

Water 2000 cc.
+
Hydrochloric Acid.

	10 cc.	20 cc.	30 cc.	40 cc.	50 cc.	60 cc.	70 cc.	80 cc.	90 cc.	100 cc.
131	O	O	O	O	O	+	+	+	+	+
"	O	O	O	O	—	+	+	+	..	..
"	O	O	O	O	⊖	—	±	+	+	..
"	O	O	⊖	O	+	+	+	+	..	..
"	O	O	O	⊖	±	±	±	+	+	..
A	O	O	⊖	⊖	+	+	+	+	..	..
B	O	O	⊖	+	+	+	+	+	..	..
C	O	O	⊖	⊖	+	+	+	+	..	..
A	O	O	⊖	⊖	—	+	+	+	..	..
B	O	O	⊖	—	+	+	+	+	..	..
C	O	O	⊖	⊖	—	+	+	+	..	..
Rose de Kol	O	O	O	O	⊖	—	+	+	..	..
Inks de Kol	O	O	O	O	⊖	—	+	+	..	..
1	O	O	O	⊖	—	—	+	+	..	..
2	O	O	O	⊖	—	—	+	+	..	..
3	O	O	O	⊖	—	—	+	+	..	..
4	O	O	O	—	—	—	+	+	..	..
5	O	O	O	⊖	—	+	..	..	..	..
Nell de Kol	O	O	O	⊖	⊖	⊖	±	±	+	+
Inks de Kol	O	O	⊖	O	—	—	±	±	+	+
Mack de Kol	O	⊖	⊖	—	±	+	+	+	+	..
Rose de Kol	O	O	O	—	±	±	+	±	+	..
Nell de Kol	O	O	O	⊖	—	±	±	±	+	+
Inks de Kol	O	⊖	⊖	—	—	±	+	+	..	..
Mack de Kol	O	O	O	—	—	+	+	+	..	..
Rose de Kol	O	O	O	—	±	+	+	+	..	..
O	26	24	16	7	1	..	..	..	..	..
⊖	..	2	10	11	4	1	..	..	..	..
—	..	..	..	7	12	8	..	..	..	..
±	..	..	..	..	4	4	5	4	..	..
+	..	..	..	1	5	13	20	21	8	4

TABLE 2—Ayrshires.

Water 2000 cc.
+
Hydrochloric Acid.

	10 cc.	20 cc.	30 cc.	40 cc.	50 cc.	60 cc.	70 cc.	80 cc.	90 cc.	100 cc.
144	0	0	0	0	0	—	+	+	+	+
“	..	0	..	0	..	—	..	+	..	+
“	0	0	0	0	—	+	+	+	..	..
“	0	0	0	⊖	—	+	+	+	..	..
“	0	0	⊖	—	—	+	+	+	..	..
“	0	⊖	⊖	⊖	±	±	+	+	..	..
145	..	0	..	0	..	—	..	+	..	+
“	0	0	0	0	0	+	+	+	..	..
“	0	0	0	0	⊖	+	+	+	..	..
“	0	0	⊖	—	—	+	+	+	..	..
“	0	0	⊖	⊖	+	+	+	+	..	..
146	..	0	..	0	..	—	..	+	..	+
“	0	0	0	0	—	—	—	+	+	+
“	0	0	0	0	—	+	+	+	..	..
“	0	0	0	⊖	—	+	+	+	..	..
“	0	0	⊖	⊖	—	+	+	+	..	..
“	0	⊖	⊖	⊖	±	±	+	+	..	..
147	..	—	—	+	+	..	..	..	..	..
“	..	—	..	—	..	+	..	+	..	+
“	⊖	—	—	±	±	+	+	+	..	..
“	0	0	⊖	—	+	+	+	+	..	..
“	0	0	⊖	⊖	+	+	+	+	..	..
“	0	0	⊖	⊖	+	+	+	+	..	..
148	..	—	..	—	..	+	..	+	..	+
“	—	—	±	±	+	+	+	+	..	..
“	..	⊖	+	+	+	..	..	..	..	..
149	..	—	—	±	±	..	..	..	..	..
“	0	⊖	⊖	—	+	+	+	+	..	..
154	0	0	0	⊖	⊖	—	—	+	..	..
“	0	0	0	⊖	+	+	+	+	..	..
“	..	⊖	0	—	±	..	..	..	..	..
“	⊖	0	0	⊖	+	+	+	+	..	..
0	20	21	12	9	2	..	..	..	..	..
⊖	2	5	10	11	2	..	..	..	..	..
—	1	6	3	7	8	6	2	..	..	..
±	..	..	1	3	5	2	..	..	..	..
+	..	..	1	2	10	20	21	28	2	7

TABLE 3—Jerseys.

Water 2000 cc.
+
Hydrochloric Acid.

	10 cc.	20 cc.	30 cc.	40 cc.	50 cc.	60 cc.	70 cc.	80 cc.	90 cc.	100 cc.
50	O	O	⊖	—	—	+	+	+	...	..
“	O	⊖	—	—	+	+	+	+	..	..
“	O	O	⊖	⊖	—	+	+	+	..	..
“	O	⊖	—	+	+	+	+	+	..	..
“	O	⊖	—	—	+	+	+	+	..	..
56	O	⊖	—	+	+	+	+	+	..	..
“	O	⊖	—	—	+	+	+	+	..	..
“	O	O	⊖	—	+	+	+	+	..	..
“	O	—	—	+	+	+	+	+	..	..
“	..	O	⊖	+	+	..	..	..	..	..
“	⊖	⊖	—	—	±	±	+	+	..	..
133	O	O	O	—	±	±	+	+	..	..
136	⊖	⊖	—	±	±	+	+	+	..	..
155	⊖	⊖	⊖	±	+	+	+	+	..	..
“	..	—	—	—	+	..	..	..	..	..
O	10	5	1	..	..	..	..	..	..	..
⊖	3	8	5	1	..	..	..	..	..	..
—	..	2	9	8	2	..	..	..	..	..
±	..	..	..	2	3	2	..	..	..	..
+	..	..	..	4	10	11	13	13	..	..

TABLE 4—Guernseys.

Water 2000 cc. + Hydrochloric Acid.	10 cc.	20 cc.	30 cc.	40 cc.	50 cc.	60 cc.	70 cc.	80 cc.	90 cc.	100 cc.
150	..	0	—	±	+	..	..	..	..	..
“	0	⊖	⊖	±	+	+	+	+	..	..
“	0	⊖	⊖	±	+	+	+	+	..	..
Pride of Place	..	—	+	+	..	+	..	+	..	..
“	—	—	—	+	+	+	+	+	+	+
“	0	⊖	—	+	+	+	+	+	..	..
“	⊖	⊖	—	±	+	+	+	+	..	..
“	0	0	⊖	—	+	+	+	+	..	..
Repose	..	—	..	+	..	+	..	+	..	+
“	0	⊖	⊖	+	+	+	+	+	..	..
“	0	—	—	+	+	+	+	+	..	..
La Belle France	..	—	..	+	..	+	..	+	..	+
“	0	—	—	+	+	+	+	+	..	..
“	0	—	—	+	+	+	+	+	..	..
Anton's M. R.	..	—	..	—	..	+	..	+	..	+
“	0	—	—	+	+	+	+	+	..	..
La Belle J.	..	—	..	—	..	+	..	+	..	+
Foam 4th	..	—	..	—	..	+	..	+	..	+
“	..	—	—	—	+	+	+	+	..	..
Prodas Sul.	⊖	—	—	+	+	+	+	+	..	..
Rumeley's R.	⊖	—	—	—	+	+	+	+	..	..
France's M. M.	0	⊖	—	±	±	+	+	+	..	..
Anton's F.	0	—	±	±	+	+	+	+	..	..
Masher's F.	0	0	—	—	±	+	+	+	..	..
“	0	0	⊖	—	±	+	+	+	..	..
Masher's M. M.	0	0	⊖	—	+	+	+	+	..	..
Anton's M.	⊖	⊖	±	+	+	+	+	+	..	..
0	14	5	..	..	..	..	..	..	..	..
⊖	4	7	6	..	..	..	..	..	..	..
—	1	15	13	9	..	..	..	..	..	..
±	..	..	2	6	3	..	..	..	..	..
+	..	..	..	12	18	26	20	26	1	6

TABLE 5—Comparison of all Breeds.

Water 2000 cc.
+
Hydrochloric Acid.

Percentages of precipitation at different strengths for milks of all breeds.

		10 cc.	20 cc.	30 cc.	40 cc.	50 cc.	60 cc.	70 cc.	80 cc.	90 cc.	100 cc.
0	Holstein	**100**	92	62	27	4	..	..	..	..	..
	Ayrshire	**87**	65	44	28	7	..	..	..	..	..
	Jersey	**77**	33	7	..	..	..	..	..	..	..
	Guernsey	**74**	18	..	..	..	..	..	..	..	..
⊖	Holstein	..	8	38	42	15	4	..	..	..	..
	Ayrshire	9	16	37	34	7	..	..	..	..	..
	Jersey	23	53	33	7	..	..	..	..	..	..
	Guernsey	21	26	28	..	..	..	..	..	..	..
—	Holstein	..	..	..	27	46	31	..	..	..	..
	Ayrshire	4	19	11	22	30	21	..	..	..	..
	Jersey	..	14	60	53	13	..	..	..	..	..
	Guernsey	5	56	62	33	..	..	..	..	..	..
±	Holstein	..	..	..	..	15	15	20	16	..	..
	Ayrshire	..	..	4	10	19	7	9	..	..	..
	Jersey	..	..	..	13	20	15	..	..	..	..
	Guernsey	..	..	10	22	14	..	..	..	..	..
+	Holstein	..	..	..	4	20	**50**	80	84	100	100
	Ayrshire	..	..	4	6	37	**72**	91	100	100	100
	Jersey	..	..	..	27	67	**85**	100	100	100	100
	Guernsey	..	..	..	45	86	**100**	100	100	100	100

An analysis of Table 5 shows that the acid used failed to form any precipitate whatever in the dilution of 10 cc. HCL+2000 cc. Water in

100% of the Holstein milks,
87% of the Ayrshire milks,
77% of the Jersey milks,
74% of the Guernsey milks,

or from the opposite standpoint,

None of the Holstein milks,
13% of the Ayrshire milks,
23% of the Jersey milks,
26% of the Guernsey milks

precipitated with this strength acid. It further shows that a positive precipitate was formed in the milk of

100% of the Guernseys, at 60 cc. strength
100% of the Jerseys, at 70 cc. strength,
100% of the Ayrshires, at 80 cc. strength,
100% of the Holstein, at 90 cc. strength,

also that at the strength which precipitated fully and completely

100% of the Guernsey milks (60 cc. strength), only
85% of the Jersey milks,
72% of the Ayrshire milks and
50% of the Holstein milks

were precipitated completely.

The point of positive precipitation was determined by getting two or more precipitates which did not vary in appearance from successive strengths of acid. The intermediate reactions were then determined by comparision and designated by the characters already given.

The only plainly evident comparable variations are those representing the absence of precipitation altogether and the point of positive and complete precipitation. There should be, and is a more or less consistent variation in the intermediate reactions, but the delicacy of the reagent is insufficient and the method of comparison so indefinite that the results are not so consistent as can probably be expected from further work along this line. The chief value of the results is to be regarded as evidence of measurable variations of the proteids which cannot be chemically differentiated.

The Appearance of Precipitates in Bulk.—When milk is added in large quantities to an excess of acid solution in the same manner as that used for single drop comparision each drop has the same opportunity for a separate reaction, and the precipitated portion gravitates to the bottom of the vessel or remains floccuIent and settles to the bottom gradually.

For this comparison milk of the different breeds was obtained from cows as nearly as possible equally advanced in the lactation period.

500 cc. of each sample were added by drops from the separating funnel to vessels containing 1000 cc. of a mixture of 50 cc. HCL and 1000 cc. water. This strength had already been proven sufficient to precipitate all proteids affected by hydrochloric acid. The vessels were then allowed to remain where the precipitation occurred in order that the agitation of liquids would not disturb the precipitates. Accurate comparisons could then be made.

COMPARISION OF RESULTS.

Holstein.

Precipitate fine, sinks slowly. Fluid turbid; remains so for several days.

Ayrshire.

Precipitate very fine, sinks slowly. Fluid very turbid; remains so for several days.

Jersey.

Precipitate coarse and sinks rapidly. Fluid clears slowly, no cloudiness remaining.

Guernsey.

Precipitate coarse, sinks rapidly. Fluid clears more rapidly with no cloudiness remaining.

After 24 hours the fineness of the precipitate and the clearness of the fluid places them in the following order:

Ayrshire.

Fluid milky, precipitate very fine.

Holstein.

Fluid slightly turbid, precipitate very fine.

Jersey.

Fluid clear, precipitate coarse.

Guernsey.

Fluid clear, precipitate very coarse.

In all cases the precipitates remained flocculent and did not tend to "clabber" as in the ordinary process of souring.

The fineness of the precipitate was further shown by the volume occupied in the vessel, which was much more pronounced than the difference in the amount of total solids would have indicated. The order in which they arranged themselves by volume of precipitate was

1. Holstein (least). 2. Ayrshire. 3. Jersey. 4. Guernsey (greatest).

Mechanical Separation of the Precipitates.

Attempts were made to separate the precipitates of the several milks mechanically into various grades of coarseness. For this purpose screens or sieves with meshes of different degrees of fineness were used but without success. The precipitates were found to be easily reduced to the same degrees of fineness when attempts were made to pass them through the meshes. There were evidences of layers of fine and coarse particles in the ordinary method of settling, but these were not of such a character that comparisons could be made.

Completeness of the Precipitation.

The filtrate from the filtered decanted supernatent fluids remained clear on boiling and did not show further precipitation with hydrochloric acid dilutions of any strength, thus showing that the acid used was of sufficient concentration. On the other hand, however, Mercuric Chlorid, Picric Acid, Almens Reagent and Magnesium Sulphate did cause slight further precipitation which was regarded as albumin. When Acetic Acid was added to the filtrate obtained from the Picric Acid precipitation there was no evidence of any further precipitation and, therefore, mucin was absent.

. Appearance of the Semi-dried Curds.

Curds made with Rennet Extract showed differences when examined after "clabbering" and before drying had been allowed to proceed too far. For this purpose the diluted Rennet Extract was placed in a beaker large enough to easily hold the milk sample. The milk was then poured from another beaker into that and then alternately poured from beaker to beaker or "boxed" until curding occurred. Just at this moment the whole sample was poured into a large beaker containing several volumes of water. This allowed the precipitated particles to become widely separated. The sample was then put aside to settle.

In settling the precipitated curd collected into a mass at the bottom of the beaker. As this mass became firm the fluid was carefully drawn from the top until the disc of curd could be handled without damage. At this stage it was treated with a mixture of glycerine and 10% formalin in order to preserve it for future comparisons. Such discs were made from a number of samples of cows milk of the different breeds and compared. The order in which they arranged themselves from the finest to the coarsest was as follows: 1. Holstein. 2. Ayrshire. 3. Jersey. 4. Guernsey.

Reactions of Milks of Other Species.

In the precipitation of the proteids with acid as just outlined there were a number of samples of human milk from different sources, samples of milk from a jenny mule and from a goat examined for comparison. The results of these precipitations are given in the following table:

TABLE 6—Human, Jenny Mule and Goat Milk.

Water 2000 cc.
+
Hydrochloric Acid.

	10 cc.	20 cc.	30 cc.	40 cc.	50 cc.	60 cc.	70 cc.	80 cc.	90 cc.	100 cc.
Mule milk.....	O	O	O	O	O	O	O	O	O	O
“ “	O	O	O	O	O	O	O	O	O	O
“ “	O	O	O	O	O	O	O	O	O	O
“ “	O	O	O	O	O	O	O	O	O	O
“ “	O	O	O	O	O	O	O	O	O	O
“ “	O	O	O	O	O	O	O	O	O	O
Human milk...	O	O	O	O	O	O	O	O	O	O
“ “	O	O	O	O	O	O	O	O	O	O
“ “	O	O	O	O	O	O	O	O	O	O
Goat milk.....	⊖	⊖	⊖	⊖	⊖	⊖	⊖	⊖	⊖	⊖
“ “	⊖	⊖	⊖	⊖	⊖	⊖	⊖	⊖	⊖	⊖

Note.—In the sample of goat milk there was a very slight and finely divided precipitate of proteid in all strengths of acid, though in no case was there a tendency for the precipitate to form a mass as in the cow's milks. It was pronouncedly flocculent, even though precipitating in low strengths of acid.

Reactions with Abnormal Cow's Milk.

In the course of the examination of the samples of cow's milk there occurred two cases in which the milk became abnormal. In one case, Cow No. 69, a Jersey, the reactions were normal until she reached a point where her milk yield became low and as a “stripper” her milk showed a very interesting reaction, as shown in the following table. In the other case the cow became affected with a digestive disturbance which resulted in a decrease of milk yield. This was followed by recovery with a return to the normal flow and a return to the usual reactions. This is also seen in the accompanying table. This Cow No. 124 was also a Jersey.

TABLE 7.

Water 2000 cc.
Hydrochloric.

	10 cc.	20 cc.	30 cc.	40 cc.	50 cc.	60 cc.	70 cc.	80 cc.	
No. 69..	0	⊖	—	+	+	+	+	+	November 3rd.
" ..	0	⊖	—	—	+	+	+	+	" —
" ..	0	⊖	—	—	+	+	+	+	" —
" ..	0	0	0	⊖	⊖	⊖	⊖	⊖	April 24th.
" ..	0	0	0	0	0	0	0	0	" 26th.
" ..	0	0	0	0	0	0	0	0	" 28th.
" ..	0	0	0	0	0	0	0	0	May 1st.
" ..	0	0	0	0	0	0	0	0	" 3rd.
" ..	0	0	0	0	0	0	0	0	" 10th.

(Reactions negative until she became dry.)

TABLE 7—Continued.

	10 cc.	20 cc.	30 cc.	40 cc.	50 cc.	60 cc.	70 cc.	80 cc.	
124..	0	⊖	⊖	—	+	+	+	+	October 31st.
" ..	0	0	0	—	—	+	+	+	November 2nd.
" ..	0	0	⊖	—	+	+	+	+	"
" ..	0	0	—	—	+	+	+	+	"
" ..	0	0	0	0	—	—	..	..	April 24th.
" ..	0	0	0	⊖	⊖	⊖	⊖	⊖	" 26th.
" ..	0	0	0	⊖	⊖	—	±	±	" 28th.
" ..	0	0	⊖	—	±	±	±	±	May 1st.
" ..	0	0	⊖	⊖	±	+	+	+	" 10th.
" ..	0	⊖	—	±	+	+	+	+	" 15th.

During the time that these samples of milk failed to conform to the reactions of the breed and to the reactions which the milks from these individual cows had previously given they were repeatedly tested with Picric Acid. In all such cases copious precipitation occurred. It was therefore due to some temporary condition of the animal which affected the character of the milk. Further observations are being made along this line and will be reported upon later.

If such results are to be gotten by the reactions to precipitating reagents as were secured in these two cases, it will afford an easy method for detecting abnormalities in milk when otherwise its appearance is normal.

General Discussion of Results of Study of Proteids.

Inability to digest and assimilate the raw untreated milk from some cows and the perfect digestion and assimilation of similar milk from other cows by an infant is the experience of nearly all physicians and others having to do with infant feeding.

Examination by the usual tests for the cause of this difference in the digestibility of such milks fails to indicate it. Both milks may have been found to have been produced under perfect conditions as far as the food of the cow and the proper care of the milk are concerned; both may have been shown to contain normal amounts of the several constituents, in fact, they may have tested alike in the content of fat and other solids, yet the results of feeding it to infants are widely different.

The breed of the cow may be the only recognizable factor in which a difference could exist, and yet there has been no measurable difference in the character of the constituents recognized, except the size of the fat globules and the flocculence of the curd.

The size of the fat globules would not seem to be an important factor in itself for the reason that in most all cases where an infant has failed to thrive upon a particular milk and is unable to digest and retain it, it is possible to give the cream from such milk with satisfactory results. Furthermore, the size of the fat globules in human milk range in size from the smallest found in cow's milk to the largest found in cow's milk, and average about midway between the Holstein-Ayrshire class and the Jersey-Guernsey class.

The flocculence of the curd has been claimed for sometime by the advocates of the Holstein and Ayrshire breeds of cows to be especially desirable for milks for infant feeding. The results of the work done in connection with the reactions of the proteids in the presence of precipitating solutions confirm the claims of these in regard to the flocculent nature of the curds and in addition show that the milks of these two breeds is not so easily curdled with the natural acid of the stomach as are those of the Jersey and the Guernsey breeds.

The results of the work done on abnormal milks are not sufficient to draw conclusions from, nevertheless, they indicate an important line of observation. It may prove possible by such reactions to determine exactly what period after calving and what time at the end of the lactation period is necessary to elapse before the milk of such cows is proper for food.

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